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CHINESE RAILROAD DEVELOPMENT, PAST, PRESENT, AND FUTURE.

By Charles Denby and E. P. Allen.

THE main interest of China at the present time in the eyes of the engineering world is as a field for railroad enterprise. Twenty-two years have elapsed since the first effort by ocular demonstration to convince China of the value of railroads. The effort succeeded only too well for official peace of mind. The conservative objections to the introduction of railways have been many and various. The principal opposition was from the censors, who affect to reflect popular opinion, and who claimed that the construction of railroads would cause desecration of the graves of the dead, and that their operation would throw myriads of laborers out of employment, and from the board of revenue, which maintained that railroad traffic would render impossible the collection of the *likin* tax, which is a species of *octroi*. But there was also a Chinese Ruskin, who protested against the defacement of China's fair land "with the gridiron of railroads that makes the western countries hideous," and he was perhaps the only genuine objector of them all. The much-talked-of popular outcry against railroads was all in the ear of the official class, and, where it really exists, no doubt owes its existence largely to official incitation. As to the *likin* tax, the mandarins did not stop to consider the willingness with which even native merchants would see that oppressive and trade-choking system abolished, and refused to admit that a change is not necessarily to be condemned because it brings other changes in its train, but held out strenuously for the *likin* simply because it gave them unlimited opportunities for peculation.

These objections came, and still come, principally from the provincial authorities. The provincial isolation, which makes it possi-

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ble for a viceroy to set himself up as a semi-independent sovereign, and leaves even lesser officials without any strict accountability, is the bane of China. If the Chinese did but know it, railroads, with the freedom of intercommunication which they establish, will be their salvation as a nation; and it matters not whether the railroads are built and controlled by them or by foreigners. When by their means the Chinese come to know themselves, they, with their industry, tenacity, and numbers, will become a power which no European nation can keep in partition and under effective control. And there have been and are some among the statesmen of China who have realized this truth and made a vigorous fight for reform. In his dying memorial to the throne the once distinguished viceroy of Nanking, Tso-Tsung-t'ang, said in 1885: "Railroads must be built. In foreign countries railroads are built by merchants, but military movements are facilitated by them. Transportation is facilitated and made expeditious, and, wherever the railroads extend, there benefits accrue. Before the railroads were made, many hindrances were thrown in their path, but, when once they came into existence, the people on that account grew rich, the countries more powerful, and goods imported were multiplied. That there is every advantage and no detriment is only too obvious. The comments of the masses are multifarious, but there is no necessity to argue with them and explain everything. As the Analects have it, 'the people may be made to follow, but cannot be convinced.' Take, for instance, the telegraph and steam navigation, things China never had before; yet, once they are initiated, they become indispensable. If railways are introduced, the benefits that will be derived are of still wider scope."

Who could say more? It is strange that so strong and direct an appeal penetrates so little the petrified conservative brain.

Marquis Tseng, one of the most able of China's statesmen, who suffered the penalty of dowager-imperial displeasure and of death for his outspoken and active campaign of reform, once sadly wrote: "[China] has failed to see that the old familiar paths, which many centuries had made dear to her, did not conduct to the goal to which the world was marching." It is a thought which calls for sympathetic pause even in this headlong western world.

The first railroad constructed in China was a narrow-gauge line from Shanghai to Woosung, put down in 1876, and intended chiefly as an ocular demonstration to the Chinese. The enterprise was initiated by Jardine, Matheson & Co., a British house in the Chinese trade, which is now again to the fore in a far more important undertaking. The contractors of this first railway were English, and one of them was the Mr. John Dunn whose name is principally connected

with the Cleopatra Needle, and who is still engaged in engineering work in the east. The engineer was Mr. G. J. Morrison. In the fall of 1876 the whole line of ten miles was opened to the public. At the end of twelve months it was sold to a Chinese official, who straightway tore up the rails and deported them to Formosa. The single dummy engine of the line now reposes peacefully in the mud of some Formosan harbor, together with the wreck of the junk in which it was transported. During these twelve months of its existence the Shanghai-Woosung railroad, with its single dummy engine and its train of small cars, which, by the way, were of the American pattern, carried three hundred thousand passengers. The Chinese came from far and wide to see and experiment with this new barbarian curiosity, and the people in the neighborhood, soon finding it an institution of great practical utility, became regular patrons. The predicted uprising of the people against the construction of the road never materialized, and, as for the graves along the route, Mr. Morrison himself is authority for the statement that every farmer would manufacture as many graves as he could get dollars for permission to traverse them. In justice to the Chinese, however, it must be explained that their action in taking up the Shanghai-Woosung railway was not without cause from the point of view of strict legal and diplomatic right. As is well known, aliens can have no rights in real property outside of treaty ports in China, except by special governmental grant. There was no grant in this case, and the construction of the railway was a stolen march, characterized, indeed, by Sir Thomas Wade, British Minister at the time, as an outrage, although there is reason to believe that the promoters were aided and abetted by the local Shanghai officials. The Chinese government demanded the abandonment of the road, and the sale was, in fact, the result of diplomatic arrangement. Upon acquiring the road it was torn up and deported by way of reassertion of injured governmental dignity.

The next railroad undertaking in China began on an even smaller scale, but it was permanent, and grew to large proportions. About the time the Shanghai-Woosung railroad had ended its short lease of life, Mr. C. W. Kinder, the engineer of the Kaiping coal mines, which were worked with private capital, constructed a tram-line for moving his coal. He was most resourceful with his limited facilities, and succeeded in transforming an old traction engine into his first locomotive. Later he built a more acceptable engine, principally out of material on hand in the shops of the company at Tongshan. From these small beginnings have sprung the very considerable railroad property of the China Railway Company, from Kaiping to Tonku, across the Peiho river from Taku, a distance of some eighty miles.

This road was completed and opened to general traffic about 1886. Mr. Kinder's resources were extremely limited, and the construction of this road was therefore none of the finest, but it was due only to his indefatigable energy that anything was accomplished at all. The fact that he was able to grasp and utilize his opportunity and to complete a railroad with Chinese capital, and under the eyes almost of the government at Peking, has no doubt advanced the railroad era in China by many years. It is at Tonku that the Kaiping coal is loaded on steamers for Shanghai and other southern ports.

In 1886 the government took a new departure, and itself determined to construct a railroad. The outcome of this determination is the line from near Peking to Tientsin, thence to Taku, and thence, utilizing the Kaiping-Tongku line, to Kaiping, and onward to Shanghai-Kwan,—a total distance of some two hundred miles. This line is now being extended beyond the great wall, and will ultimately reach Newchwang. The Peking terminus is four miles from the city, and connection is to be made by an electric line, the contract for the construction of which has been taken by the German Siemens-Halske Electric Company. The engineer of the railroad is Mr. Kinder, and up to last year the chief Chinese manager was Ng Choy, a man of marked ability, a member of the British bar, and now minister at Washington, known to us as Wu Ting-fang. The portion of the road from Taku to Tientsin was opened in 1889, and none too soon, for the Peiho had become so blocked with detritus that no steamer could enter so far as Tientsin, which is the great commercial gate of Northern China and Shanghai's nearest competitor in the trade of the empire. At the present time no steamers go above Tongku, which is a few miles below Taku, and on the opposite side of the river. The great value of this line for commercial purposes did much to convert the Chinese mind to an acceptance of railroads.

The equipment of the imperial system is of varied character, but, on the whole, it follows American patterns, particularly in the matter of the cars, which are built at the Tongshan works. The first train started out with Janney couplers and Westinghouse air-brakes, the latter a present from the patentees to the government. The road is ballasted with stone, and the ties are principally of hard Japanese wood. Lately American ties have also been imported from the Pacific coast. The permanent work is iron, steel, or stone masonry, to suit climatic conditions of extreme heat and cold. The road-bed is raised, with the necessary flood-openings. The gauge is standard.

The most important railroad undertakings of the near future in China are the projected lines from Hankow to Canton. The concession for the northern line has been granted to a Belgian syn-

dicate, which is alleged to be a stalking-horse for Russian interests. The fact that 75 per cent. of the trade of Hankow is in the hands of Russians lends color to this belief. The concession itself has been subjected to serious criticism, on account of the unfavorable terms to its holders, and the Belgians are thought to have been rather too precipitate in their endeavor to get ahead of rival syndicates; but, if it is really Russian interest behind the syndicate,—which, however, is denied by Russia,—Russia may be counted upon to secure modifications when they become desirable. The Russian bear has a certain gentle insistence, before which it is very hard for even a Chinaman to remain immovable. The construction of the Belgian syndicate is to be known as the Luhan road. About thirty miles of it at the Peking end have been completed, and the road-bed has been laid as far as Pao-Ting fu. Eight Rogers Mogul engines recently arrived near the scene of operations, and are awaiting the completion of additional road before being put in service. The work is now awaiting the arrival of rails from the Han Yan works at Hankow, which were established by Chang Chih-tung when a Peking Hankow road was first contemplated some years ago, he being furnished with an imperial rescript to proceed with its construction. The rails rolled at the Han Yan works are said to be of inferior quality, and it is doubtful if they will be utilized. The pig iron is made at the same works, and the coke employed for this purpose is brought partly from Tongshan, but partly, at a cost which may be imagined, from Europe. In this case, at least, China's desire to depend upon her own resources is costing her a pretty penny. But she may live to find that her experience was not too dearly bought. A commencement has to be made; not long ago steel rails in the United States sold for more than $100 per ton.

The total distance from Peking to Canton is from 1,400 to 1,500 miles, and Hankow is about half-way between. The only serious engineering obstacle to be surmounted in the northern half is the Yellow river, with its ever-shifting bed. The bed of the stream, in its lower reaches, is some fifteen feet above the surrounding country. The river, because of its frequent disastrous overflows, by which sometimes thousands of villages are destroyed, and tens of thousands of helpless natives drowned or rendered homeless and ruined, has long been known as "China's Sorrow." The first record of an engineering attempt to prevent the overflow was in B. C. 2293; for more than four thousand years China has sacrificed her life and wealth to this insatiable monster. The successful solution of the problem of the Yellow river is an accomplishment which might well satisfy the most ambitious of our engineers. Perhaps the necessities of the Lu Han railroad will bring to bear the requisite attention and effort. But whether

the necessary capital could be provided in any near future is more than doubtful. In the meantime an American engineer, Mr. Rich, is recommending a ferry as a temporary solution of the difficulty.

The concession for the construction of the southern road from Hankow to Canton has been granted within the last few months to an American syndicate headed by Senator Calvin S. Brice. This syndicate will spend $100,000 in preliminary work, and, on the signing of the contracts in Washington, made a deposit of that amount as an evidence of good faith. It is taking time by the forelock, and its engineer, Mr. W. Barclay Parsons, of New York, is already on his way to the field of operations. The estimated cost of the road is $40,000,000. The bulk of the material used will probably be American.

A British syndicate, headed again by Jardine, Matheson & Co., is undertaking the construction of a railway from Shanghai into the interior, which is of the greatest commercial importance. The road will run from Shanghai through Soochow, eighty-five miles inland, thence to Chinkiang, one hundred and twenty miles up the Yangtze at the entrance to the Grand Canal, and thence to its terminus at Nanking, the viceregal capital of Kiangsu. The province of Kiangsu, traversed by this road, has a population of some forty millions, and the cities on the route of the road are among the most important commercial centers of the empire. The little road which has again been built between Shanghai and Woosung, this time of standard gauge, was opened on September 12 of this year, and will one day be merged in the Shanghai, Soochow, Chinkiang, Nanking line.

When a longitudinal trunk-line in China was first discussed, several routes were considered. The government settled its preference on a line from Peking through Hankow to Canton, alleging as reason therefor that, in time of war, it would be safer from attack than a line nearer the sea. That reason may be cogent enough for its purpose, but from a commercial point of view it surely seems that the best longitudinal line would be one constructed from Peking southward along the route of the Grand Canal, which should connect with the great Shanghai-Nanking line at Chinkiang and go on to Hangchow, which is the southern terminus of the Canal, and an important trading center of some four hundred thousand inhabitants. In the words of Mr. Colquhoun, "such a line would pass some forty towns with an average population of twenty-five thousand each, and a large number of villages. The length of the Grand Canal from Tientsin to Hangchow is six hundred and fifty miles. No better line exists in the world, from the point of view of population, resources, and cheapness of construction. It follows the most important of the actual routes of commerce in the empire, passes the greatest possible

number of cities, towns, and villages, and connects great ports with rich coal regions of established value."

In connection with a proposed line on the grand canal route an interesting case recently arose. Yung Wing is a Chinese subject well known in the United States. He had charge of the Chinese students who, about twenty years ago, were sent to America to be educated. His residence is Hartford, Connecticut, where he married and raised a family. He was naturalized in 1852, and has voted at every election since that time. He is the bearer of several passports issued by the secretaries of State. Recently he went to China to secure a railroad concession. He was granted the right to build a line from Tientsin to Chinkiang. As Chinkiang is about one hundred and thirty miles from Shanghai, the road from Tientsin to that place will be a strong competitor with the Peking-Hankow line. Hankow is six hundred miles up the Yangtze, and Shanghai is at its mouth. In doing the business between the great port of China and the north, the Chinkiang line, being shorter than any other, would have the preference. Chang Chih-Tung, who was interested in the line from Hankow to Peking, for these reasons protested against the granting of this concession to Yung Wing, but a greater power than Chang Chih-tung entered the lists.

The German minister protested that, under the convention between China and Germany, China had no right to grant to the citizens of any country but Germany the right to construct a railroad through Shantung, and he demanded the annulment of the right granted to Yung Wing. The Yamen meekly obeyed, and advised Yung Wing to make terms with the German minister. Yung Wing appealed to what he thought was his own country, but was advised that the State department did not recognize that any Chinaman, either before or after the act of 1882, could be naturalized in the United States, and, as he was not a naturalized citizen, the government could not intervene in his behalf. It is reported that Yung Wing followed the advice of the Yamen, and has made an arrangement with German subjects to build the road.

This case came near raising the important question as to what action the United States would take if China were to carry out the German view of granting to one country alone the right to construct railways in any province. The favored-nation clause in all the treaties provides that all the rights and privileges granted to the most favored nation shall be granted to the nation with which a treaty is made. There can be little doubt that a decree by China that the citizens, or subjects, of one nation should have the exclusive right to build all the railroads in China would be resisted by the European powers. It

seems that the same principle ought to govern with regard to each of the provinces of China. Anxious as England is to avoid war, public sentiment would force her to fight over the assertion of an exclusive right by any nation to build railroads and operate mines in any province, provided an Englishman had demanded such a right, and had been refused. She will, probably, take care that no such case shall arise, and thus avoid trouble.

The fact that British enterprise is not contenting itself with the Yangtze valley limits, which other nations seek to assign to it, was referred to in the last number of THE ENGINEERING MAGAZINE. The immense mineral concessions of Shansi are the richest prize that has fallen to any syndicate, and the Peking syndicate which has obtained them is principally British in its make-up. These mineral concessions carry with them the right to construct railroads in order to open access to the ore beds and for general traffic. The coast-side outlet of the region will, presumably, be Tientsin, and the road doubtless will take in the capital also, on its way to the west. The right of the Peking syndicate to continue its lines of railway through Shansin and beyond the borders of Honan has been but lately recognized. Since neither Shansin nor Honan contains any treaty port, and since the Peking syndicate will hardly wish to depend solely on the Belgian (Russian?) Luhan road for a southern outlet, its ultimate aim doubtless will be to reach the Yangtze on its own account, as has recently been surmised by the London *Times*.

Another British syndicate has been granted the right to construct a railroad from Kowlung to Canton, thus connecting this most populous of Chinese cities with a British possession on the coast. And in the southwest a road is being built from Mandalay, in Burma, to a point in the Salwen river close to the southwest corner of Yünnan,—a distance of two hundred and fifty miles. In due course this road will be pushed on through that rich province, once the most secluded in China. There are engineering difficulties in Yünnan, however, which make that enterprise less attractive than many another.

The Germans are talking of building a railroad inland from Kiao Chou, but no details of their plans are settled. Meantime the French concession for a line from Tonking toward Canton does not seem to be pushed. The London *Times* suggests that the Frenchmen "are satisfied with the diplomatic success of procuring the concession, and seem to have no immediate purpose of following it up by the less agreeable process of finding capital." The above is a full statement of completed and projected railroads in China proper, and in the empire as well, except the lines in Manchuria, which are to connect with, and really form a part of, the Russian Siberian system. These

lines are not Chinese, despite the association of emblems in the flag of the so-called Chinese Eastern Railway, and in any event they have been so often described of late as to be well known.

As this article is being prepared for publication, serious and conflicting news comes from China. The emperor's deposition and his death have been reported, and the disorganization of the empire, and its consequent partition, are predicted.

Capital will look seriously into these questions before any investment is made in China. It is, therefore, proper that the writers of this article, who have had some experience in Chinese matters, should give their opinion as to the probable permanence of the Chinese government.

There is not much probability of a partition of China. Germany, Russia, France, and England have seized what they want of the territory of China. They recognize that she is the greatest market on earth for their manufactured goods, and the greatest field for industrial enterprise. They have no interest in dividing her up into hostile camps, in checking production, and paralyzing progress. The more the Chinaman is civilized, the greater purchaser of imported goods he becomes. If every man in China wore a shirt, the sale of shirtings would keep all the mills in the United States busy; and so with other articles. Missionaries and commercial agents are teaching them to wear shirts. With sound plausibility the continental nations could demand a concession to enable them to establish coaling depots. In these days of steam such places are necessities for warlike, as well as commercial, purposes. To seize the interior would be wanton spoliation, and would accomplish no good purpose.

Nations are governed by self-interest. It is the interest of the world to preserve the autonomy of China. It is particularly to American interest to do so. To carry out this view the United States need only hold the Philippines, which they claim as their own by conquest. Holding these valuable islands, they do not need to take any part of the mainland of China.

If the question of partition is disposed of, there remains the danger of popular revolution, which might result in splitting China up into several parts, each under a separate government. In the opinion of the writers there is no such danger ahead for China. Let it be remembered that the history of China dates back six thousand years, and that during all the time her government has controlled, and taken care of, one-fifth of the population of the world. Let it be recognized that the Chinese have been reasonably well clothed and fed and governed. As much happiness and contentment prevail in China as anywhere in the world, except our own land. The world

knows that the attachment of the Chinese to their home is phenomenal. Could such attachment exist, if their home was not a happy one? The Chinese people are not patriotic in the western sense, but they love the land, the country, the family, as no other people in this world do. They are eminently peaceful. They abhor disorder. They do not talk politics. They have had attempted revolutions and intestine wars,—mostly on real or supposed religious questions,—but all nations have had such experiences.

It must be said, also, that at this hour China is in the hands of a strong, intelligent, and revered woman—the empress dowager. She is one of the historic characters of the world. She ruled China for thirty years during the most difficult period of its history,—the period when foreign plans and methods were being introduced, and new ideas, thoughts, and schemes were driving out the old,—a period during which seclusion was to give place to an active participation in international affairs. She ruled China well. Talk of her killing the emperor! Why should she do it? He is her most devoted, loving, and affectionate child. He worships her, and she loves but one thing on earth more than she loves him, and that is her country. She is sixty-four years old. She saw the young and weak emperor beset by factions, dragged hither and thither by the bribed agents of one country and another, and she took again, in her worn, but strong, hands, the reins of power. She will hold them as she held them when in 1862 she sent the bow-string to four of the leading men at Peking who dared to conspire against her. She and Prince Kung ruled China, and, when Kung proved false or feeble, she dismissed him from the foremost place in the empire. She is a great woman. Her people adore her, and foreigners respect her. The troubles of China came after she retired from power. They would never have occurred, had she remained regent. The writers of this paper have confidence in her power and her love of country, and they conclude that capital may be safely invested in China.

And the possibilities of returns are boundless. As China was prompt to adopt the railway for its utility, she will adopt the tramway, the dynamo, the motor, the pavement and water supply and sewerage systems, and eventually all the vast engineering applications which characterize western civilization. Different in his mental and moral philosophy, the Chinaman is like the Caucasian in his physical needs, and will be quick to seize the methods and the machinery of production which have become essential to the life of the western world. China, therefore, offers a market, of inconceivable extent, for the engineering products and the engineering talent which the Anglo-Saxon has in superabundance and seeks to sell.

EQUIPMENT, MANAGEMENT, AND ECONOMIC INFLUENCE OF THE SHIP CANAL.*

By W. Henry Hunter.

DR. ADAM SMITH, who formulated afresh for our forefathers the first principles of political economy, opened his methodical "Inquiry into the Nature and Causes of the Wealth of Nations" by a dissertation on the division of labour, in which he showed that such division was at once a characteristic feature in the progress from a rude state of society to a more complex social condition, and a factor which made for still further progress to still greater improvement.

In the manner of speech of more modern men, that progress has been styled the "march of civilisation," and the rate of advance has been such that the philosophers of the last century, in the most sanguine dreams of their most ardent optimism, could never have even imagined the possibility of such attainment as has already been achieved.

And there can be no halting on the way, much less any standing still; that which humanity has already achieved is a compelling force, making it a necessity for humanity to press still further forward, for "there remaineth yet very much land to be possessed," and the demands of the people become more *exigeant* as well as more articulate as the possibilities of supply are brought more distinctly within their range of vision.

*The only sound engineering progress is that which harmonizes with, and therefore advances, the great economic evolution which is moving so rapidly in the modern world. Engineering is, in fact, applied economics—the practical working out of material growth. For this reason, the engineer, above all others, is most vitally concerned in questions which are too frequently considered by him to belong to the sphere of the economist or the politician—questions of finance, of tariff, and of national policy.

It is emphatically in the spirit of conceptions as broad as these that the maritime canal must be studied. It is a part of the industrial equipment of the world, ministering to the advantage of all lands, though the service may not be identical to all, either in extent or in the ends to which it ministers. Such effects are too wide to be judged by the ordinary financial tests. The return to investors measures but a fraction of the total gain.

It is with the greatest pleasure that THE ENGINEERING MAGAZINE presents Mr. Hunter's articles, which carry the force of the specialist's authority and the inspiration of the broad view which sees enterprise of this character in its true perspective, as a great factor in the stupendous work of utilizing, to the fullest, the material resources of the earth.—EDITORS.

In the onward march the principle of division enunciated by Adam Smith still obtains, and still will obtain,—must, indeed, become an increasingly dominant force, for the field of its operation is widening, and will widen until it includes the whole earth, and brings under its dominion the entire surface of the planet, whether land or sea.

The reason for this lies at the foundation of things. On the globe, the only sphere of existence of which we have, as yet, experimental knowledge, population is increasing in geometrical ratio,* while the area from which the support of the people is drawn is absolutely stationary and cannot be sensibly increased. The demand for the means of subsistence multiplies, and the resources from which that demand must be met cannot be extended. Economic necessity, therefore, is impelling humanity, even unwittingly, to seek to increase the utility of the food and comfort source, seeing that the possibility of increase in any other direction is denied.

At the present time the effort to obtain larger and more luxurious supplies from the earth is being pursued on well-defined lines of least resistance.

Sir William Crookes, in his recent presidential address to the British Association, indicated other lines, less defined, but not less important, upon which the effort may be pursued in the future,† but, for the present, that with which practical men concern themselves is their recognition of the fact that the instant need is the pressing need, and that scientific provision for instant need is laying a foundation upon which posterity may build in its effort to supply its own needs, although they may be followers, either in sentiment or in manner of expression, of the worthy municipal ruler who, from his place of proud pre-eminence in his own parish, declared that "posterity had never done nowt for him," and deduced from that unassailable premise the conclusion that it was unnecessary for him to take into his consideration any question as to provision for the wants of posterity.

In days hidden in the mist of antiquity the earth was divided among families and tribes, who, as time wore on, developed into antagonistic States and clashing nationalities. In these modern times the earth is being re-divided; for its different parts, under the force of circumstances, are gradually coming to be employed for the purposes for which they are most suitable, whether of an agricultural or

* Absence of reliable statistics makes assurance impossible, but it seems safe to assume that the population of the globe has doubled during the course of the present century.

† "Through the laboratory starvation may ultimately be turned into plenty,"—*i. e.*, by the extraction and utilisation of atmospheric nitrogen.

a manufacturing sort, or of a sort fitted for the rearing of cattle or of the sinking of mines.

It may be admitted at once that glaring exceptions to this rule of progress still exist. Still the half-starved Irish peasant strives to grow oats or barley on the bleak hills of Galway or on the stony wastes of Connemara; but the wretchedness of his condition and the misery of his surroundings bear witness to the futility and the folly of the effort to struggle against the fitness of things.

Still, too, the advance of the tide is impeded and checked by the artificial barriers of national jealousy and of racial antagonism; by hostile tariffs, in which, as well as in frontier fortresses and armed outposts, the traditions of past ages of tribal division find expression to day, and which operate effectively as hindrances to the ready distribution of the products of the earth.

The strivings against nature will cease; men must, of necessity, learn to work on nature's lines, instead of against them, and the artificial and anachronistic barriers will be swept away, not because fiscal experts will cease to wrangle or to prose, not because governments will become more enlightened or men less selfish, but because needs must when hunger, or feared hunger, drives, and because humanity will come to understand that the only hope of support for the race is to make the most of the potentialities provided for that support, and will, as a consequence, treat the earth as a common heritage, with its parts employed for producing that for which they are respectively most fitted.

The working out of this, which, after all, is but a modern commentary on ancient words of wisdom,—for it is long since it was written that "the profit of the earth is for all, the king himself is served by the field,"—has actually begun, and men are experiencing some of the benefits of its operation, even though they are unconscious of the significance of the movement.

But it has only begun, and, as the population increases and the waste tracts, now so rapidly being overrun, are absorbed so that none are left, the movement will be more rapid, more intelligent, and more full of purpose.

The fact that the movement has begun and will extend is the case for the ship canal, for the waterway, wherever it may be practicable, of dimensions sufficient to afford passage to the great ocean-going carriers of produce.

This may seem almost like an anti-climax; but it really is not so, and very little consideration will make this clear.

The proposition is that, in order to draw from the earth the maximum amount of sustenance for the support of humanity, the surface

of the earth must be divided in such manner that its different parts will be devoted to the production of the commodities for which they are most suitable.

The corollary to the proposition is that, in order to make those commodities available for all, the different parts must be united by such means of transport and distribution that the fruits of the earth and the products of human labor may be conveyed rapidly and cheaply from any one part of the globe to any other part.

There are still some who, following in the lead of certain of the great men of the century, talk with a fine scorn of the search after cheapness in any direction; but the school is moribund, will soon be defunct, and is, and always has been, without any influence on the trend of events.

The late Prince Consort, whose beneficence of mind and clearness of vision are much more fully understood now than they were by those who were his contemporaries, once said with profound judgment: "Seas do not divide continents; they unite them." The sea is the great highway which nature has provided for the service of humanity, the means by which produce can be distributed and thus rendered universally serviceable.

But it is requisite that the work of nature should be supplemented "by art and man's device" in order to develop to the maximum the utility of the earth.

Seas unite, but they are themselves divided; hence the Suez canal, with its wealth of benefit to the families of mankind; hence, too, will be the Panama canal, the construction of which is one of the most pressing necessities of our own time,—a construction which is actually progressing, and in respect of which more has been achieved than the vast majority of people even imagine,—so much, indeed, that the practicability of the completion of the great inter-oceanic waterway has been demonstrated, actually proved by trial, and that the expenditure of money and of time required for completion can be, has been, forecast, and will be foretold with little less than absolute precision.

Hence, too, in minor degree (minor only in the sense that the distance of sea voyage saved is shorter), the noble Baltic canal,—the Canal de Kiel, as it is styled by its German constructors,—which unites the German ocean and the Baltic sea, and of which the benefits are but beginning to be felt, so conservative is the human mind and so slow to rise to its opportunities, and the Corinth canal, which connects the Ionian sea with the classic waters of the Ægean.

To these are to be added the American projects, greater and smaller, —the first for a waterway which will connect the group of great inland

seas between Canada and the United States with the Atlantic seaboard, and the second for a canal across the curious "mailed-fist"-like promontory known as Cape Cod, which will form a fresh connection between the bays of Massachusetts and of Cape Cod and the Atlantic.

These waterways, whether *in esse* or *in posse*, will serve as examples of the first great class of maritime canals,—those which unite divided waters, and thus form part of the highways of the world.

But there is a second class of ship canals, little if any less important than the first, though certainly in each case more local in effect.

The practical effect of a canal of the second class is to enable the sea, the highway of the nations, to penetrate the land to an extent commensurate with the length of the waterway, or, in other words, to push the seaboard inland, and that without waste of useful area or destruction of foreshore.

Of this class are the Amsterdam canal, the Ghent canal, the Pontiloff canal from Kronstadt to St. Petersburgh, the Heyst canal, now in course of construction, which will place the ancient city of Bruges once more in direct communication with the sea, and, last, but not least, the Manchester ship canal.*

The distinction between these two main classes of waterways lies in the broad fact that a canal of the first class is a through road; a canal of the second, a *cul-de-sac*, a road with a dead end.

In the first class, there is no terminus, and no necessity for terminal works. Certainly works are required, and are to be found at either end of the achievement of man's device, where art joins hands with nature, such as quays, piers, breakwaters, etc., but these are but junctions, and the course of a vessel is uninterrupted, is always onward, whether in the ocean, the junction works, or the canal itself.

In the second class, when the vessel has arrived at the end of the canal, she has reached at once the end of her journey and the point from which she should depart for her next voyage—the point from which she *should* depart, but not necessarily the point from which she *will* depart, as this depends upon the facilities which exist for enabling her to obtain a return cargo, as well as for placing that cargo in her holds.

It is obvious that the requirements in respect of equipment differ widely in the two classes.

In the first case, all that is required is that the vessel should be able to steam through the canal with as little loss of time as possible.

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*To these might be added, as somewhat similar in practical value, the estuarial improvements which have been carried out, as on the Seine, by which large vessels have been enabled to reach Rouen instead of being obliged to stop at Havre, as of yore, or as on the Clyde, where the results of the magnificent works executed may be seen by those of the most dim vision in the present position and prosperity of the city of Glasgow, and of the surrounding district.

Provision should therefore be made to allow her to pass, without danger or undue delay, another vessel whose course lies in an opposite direction to her own. It should also be competent for any vessel which had run short of coal, or of fresh water or provisions, to obtain such at either end of the waterway, or, if the need were for special surgical assistance or hospital accommodation for passengers or crew, to find that need provided for.

This is about all that is required in the way of equipment for the through-road canal, and, having provided this, those responsible for its direction and administration can be asked for little more.

Far otherwise is it with the canal of the second class. If that canal is to prove a success, is to fulfil the requirements of its being, its terminal equipment must be of no mean order, and must follow many ramifications and provide for many complicated services.

In the first place, room must be found for the concurrent berthing, in safe, sheltered, and accessible positions, of many large vessels; this necessitates the widening out of the terminus of the canal into commodious dock spaces, bounded by quays and wharves, against which vessels, great or small, may lie in comfort, and to which they may be secured by means of the mooring posts or bollards with which the quays must be fitted at short and regular intervals.

Then the vessel herself is provided for. The next consideration is her cargo, for it is presumed that she has arrived, and is intended to depart, laden; or, in other words, that there is both an import and an export trade to deal with.

Cargoes are almost infinite in their variety. There is nothing produced, grown, or manufactured upon the earth that does not find its way on shipboard and help to swell the heterogeneous mass. With this mass the terminal equipment must be capable of dealing, with promptness, with dispatch, and with avoidance of injury.

In some of the older ports the practise is even yet to require the vessel to complete her discharge by means of her own tackle; and under some specially favourable circumstances the operation is carried out with remarkable dispatch. But the port provided by the terminus of the maritime canal cannot be of ancient date, as that canal is of modern development, and in the modern port the shipowner or charterer will expect to find modern equipment.

A regiment of cranes, must, therefore, be provided, and five or six, or even seven, may be required to work at once at the discharge of one large steamer, and, as it is impossible to determine the precise spot at which any particular crane may be required, the cranes must be made movable, and, as they must be operated with great rapidity, it is essential that they should be operated by power.

Until comparatively recent times power was applied to such cranes by steam, either directly through a small engine forming part of the structure of the crane, or indirectly through water under pressure, the pressure usually adopted being from 700 to 1,000 pounds to the square inch. But within the last decade a formidable competitor with both the steam and the hydraulic crane has made its appearance in the field,—*i. e.*, the electric crane. It is not possible to discuss, within the limits of this article, the merits and demerits of these types. Each has its advantages and its disadvantages, and the final decision will lie with the type of crane by which the work demanded can be done most readily and most cheaply. It looks at present as if in the struggle for existence the electric crane would survive as the fittest of the three. At any rate, the results of the only exhaustive tests of the three types—those made in 1892–93 in Rotterdam by Mr. de Jong, the engineer-in-chief to the port, where the three are actually at work side by side—certainly indicated that this conclusion will be reached.

The cranes, or the ship's tackle, or perhaps the cranes and the ship's tackle combined, having landed the cargo on the quay, it is requisite that provision should be made for its immediate removal. Quay space is limited and valuable, seasons are short and condensed, and it is one of the problems ever present with the management how to deal with a maximum tonnage on a minimum space and in a minimum time.

The cargo, once landed, must then be got away at once. With a well-devised system of roads and railways, combined with a little foresight on the part of the consignees, a portion of the cargo may be loaded direct into lurries or railway trucks, and forwarded at once to its destination; but this can be, at the best, but a small percentage of the whole, and the rest remains to be disposed of.

For heavy, rough materials, such as timber, pig iron, slates, ores, etc., out door storage grounds are sufficient. These storage grounds, however, must not only be levelled and drained, but should be accessible, and should be traversed by railway lines and intersected by cart roads. As it is a *sine qua non* that the materials should be placed upon the ground at once, and eventually removed therefrom as expeditiously and economically as possible, with a minimum amount of handling and carrying, it is essential that the area of the storage ground should be sufficient to admit of much detail of classification of the material stored, whether of marks, or of sizes, or of quality.

There are other materials as bulky as any of the above named, such as cotton, wool, grain, etc., for which protection from wind and weather is indispensable. The same remark naturally applies als to

all manufactured goods, whether imported or for export, to all food stuffs, and to such commodities as fruits and vegetables.

The necessity for protection "calls for" shed accommodation on an extensive scale. Cargoes have become enormous in bulk and in variety,* and must be differentiated and classified as they are discharged into the sheds. Quay space is difficult and costly to obtain, particularly quay space which is within the limits of the radius of the cranes. These circumstances have led to the evolution of the type of shed in which the quay space available is multiplied by the addition of upper floors, or stories, to the original single-story shed. The single story was first doubled, then the two story shed became a shed with three floors, and now all the docks of the Manchester ship canal sheds have been or are being built with four floors, all being within the reach of the hydraulic cranes which work on the dock side and which swing the goods on to the tilting platforms with which the floors of the sheds are respectively furnished.

But the demand for accommodation advanced by trade cannot be held to be fully met by the supply of a large and convenient shed space. Goods are imported for which no present market may be found, or of which the market price may be expected to rise; and it is required that they be housed for weeks, perhaps months. For this purpose the transit sheds are unavailable by reason of the necessity of turning over the largest possible tonnage at each berth in the docks. Warehouses, therefore, must be provided. It is not essential that these warehouses should occupy quay space or encumber berths which may be more profitably reserved for more nimble traffic. It is necessary only that adequate railway connections between the discharging berth and the transit shed, on the one hand, and the warehouse, on the other, should be provided, so that the goods may be conveyed to their place of lodgment at the least possible cost, and in the shortest possible time.

Even the provision of ample warehousing room does not exhaust the demand, which is, in truth, inexhaustible. Special lines of traffic must be specially provided for, if the canal terminus is to fulfil its purpose and to keep abreast of the times. Take, for instance, the grain trade, already pre-eminent in its importance, and likely to increase rather than diminish as the re-division of the earth's surface proceeds. Take, too, the oil trade, annually growing greater in bulk, and more

*"The following are the particulars of a cargo recently discharged at Liverpool: 605 head of cattle, 2,634 quarters of dressed meat, 50 rounds of dressed meat, 342 logs of walnut, 6,588 bundles of lumber, 444 hogsheads of tobacco, 1,500 pails of lard, 425 tierces of lard, 1,338 boxes of bacon, 18,450 sacks of flour, 5,000 qrs. of wheat, 3,000 qrs. of corn, 2,193 parcels of hardwood, 839 boxes of hams, 479 bales of cotton, and a large amount of other merchandise."—*Shipping &c. Gazette*, September 8, 1898.

necessary for human comfort and advancement, for it is truly an enlightening trade, dispelling the gloom of dark hours and helping the people to lengthen their days by stealing more than a few hours from the night in the winter seasons.

Whether regarded from the point of view of the port of origin, or that of the port of distribution, both these lines of traffic demand special provision. The quantities to be dealt with have become so enormous that the old-fashioned methods of handling grain in small parcels and of moving oil about in barrels are hopeless to-day. Now the grain must not only be loaded or discharged in vast quantities, but be weighed and stored in such manner that these great quantities can be so divided and sub-divided that, without appreciable addition to the cost, shiploads of thousands of tons can be rapidly and certainly distributed in lots of 60 tons, or even in smaller quantities. To meet this necessity the American grain elevator has been evolved. Of that elevator space forbids any detailed description here. It must suffice to say that it has successfully invaded even the British islands, in which, as Edmund Burke said, "men's minds move slowly"; that its conquest of the grain trade will be sure and complete; and that the provision of some sort of elevator as an essential part of the equipment of any ship canal must now be recognized.

For the oil trade the provision is of a more simple character. The tank steamers in which the oil is now carried, in bulk, are fitted with all necessary pumping power for the loading or discharging of their cargoes, and require only a safe berth with pipe connections to the great circular tanks, something after the appearance of gas-holders, in which the oil is stored for distribution.

Without stopping to dwell upon the minor, but still absolutely essential, parts of terminal equipment, such as electric lighting, fresh-water-supply for vessels, fire protection appliances, etc., we pass to the all-important question of the means of distribution or collection of goods, whether imported or to be exported.

Apart from such means, all the rest will be bootless. Where a system of inland canals exists, such system should be not only utilized, but developed, difficult as such development may be in most countries to-day, owing to the short-sighted policy of the past. But the inland canals can take only a small part of the traffic with which the maritime canal can deal. Hence the necessity that to every dock or arm of a dock, to every transit shed and every goods warehouse, as well as to every storage ground, a good and convenient cart-road should be formed, so that the road may supplement the canal for collection and distribution.

But road and canal together will be found totally insufficient for

the transport of the mass of merchandise to be dealt with. Therefore, wherever the road may be carried, the railway must follow. Not only a railway to each dock, or shed, or warehouse, but a railway on each side of each. Nothing else will suffice. This network of railways will involve the formation of through roads, over which all the goods may be conveyed, and of sidings of no ordinary dimensions,—marshalling sidings, stock sidings, etc., by means of which the goods may be sorted and the trucks apportioned.

The result of all this will be that, under the pressure of circumstantial necessity, the docks forming the terminus of any large waterway will develop not only into a vast emporium of merchandise, but into a huge railway goods station, and the equipment of such a station becomes part of the equipment of a great ship canal.

The capital cost of these works is, of course, very heavy, but judicious capital outlay will have a marked effect in the reduction of working expenses and of maintenance, and such outlay will be found to be money well spent,—money for the expenditure of which the human family will be the better, so far as the necessities and the comforts of life are concerned.

And no end can be discerned to the benefit, for it increases year by year.

(*To be continued.*)

OLD AND NEW FORMS OF THE SUSPENSION BRIDGE.

By Gustav Lindenthal.

IT is interesting to note that the oldest form of bridge—the suspension bridge—is the slowest in development into rational forms in iron and steel. While every other type of bridge—the beam or truss, the girder, the arch, and the cantilever—has been thoroughly exploited, correct theories and construction details for all of them having been established, the suspension type has only recently received close mathematical consideration, with a view to making it serviceable for the concentrated loads of modern railroad conditions.

Suspension bridges, as every one knows, are as old as mankind, and are found in all parts of the world, among savages as well as among the oldest civilizations. It was natural to bridge a stream or abyss with ropes of twisted vines, sticks laid across them forming the footpath. That some very bold constructions of this primitive kind were carried out is shown by a description (*Engineering*, 1892, I, page 2) of such a bridge in the Caucasus; it had a span of eighty feet, carrying a mule path, and the ropes consisted each of three twisted creeper stems. It required only the knowledge of a stronger tension material, like wrought iron, to suggest that construction for longer spans among more advanced nations. And, indeed, all the first historic iron suspension bridges, as early as the sixteenth century in China, were built on this primitive model, the path or road resting directly on the iron chains. So also were the first wrought-iron chain bridges in England, about the middle of the eighteenth century.

A horizontal roadway, supported by vertical rods from the chains above, was an improvement introduced for the first time in 1796, in North America, by James Finlay, a New England native. He built spans of three hundred feet, in which the chains consisted of long links, or rings, forged of round or square bar iron. Bridge chains consisting of the more serviceable flat link or eyebar were first manufactured in London by Samuel Brown (in 1811), and the facility of erection which they afforded induced the eminent engineer, Telford, to use that system for the famous and still well preserved bridge over the Menai strait, with a span of six hundred feet (1818–26).

The production of puddled iron in large masses, and its gradual cheapening in the beginning of this century, changed the character of iron bridge building completely. Until then cast iron had been used in the form of arches; but it was found that wrought-iron suspended structures were more easily and cheaply built. After several badly-

HAMMERSMITH BRIDGE OVER THE THAMES, LONDON.
Built by W. T. Clarke 1827.

designed cast-iron bridges had collapsed in England with disastrous results, wrought-iron suspension bridges were preferred, and during the first half of the century were the fashion everywhere.

In rapid succession were built many of the architecturally famous structures: the Hammersmith bridge in London (400 feet span, 1827) by W. T. Clarke; by the same engineer, the beautiful bridge over the Danube at Buda Pest (600 feet span, 1839–45); the Seraing chain bridge in Belgium (350 feet span, 1843), the first suspension bridge with iron towers; and the fine chain bridge in Prague (two spans of 420 feet each, 1838–42), by Schnirch, the engineer who built later the only railroad suspension bridge in Europe, over the Danube canal in Vienna (taken down and rebuilt in 1885), and in the same city the fine Aspern bridge (200 feet span, 1865). The longest span with flat eyebars in Europe is the Clifton bridge at Bristol, England (700 feet span, 1840–64), built by Brunel & Hawkshaw; while the Point bridge at Pittsburg, Pa., by Hemberle, is the longest of that kind in America (800 feet span, 1876).

It is not generally known that the first use of steel in bridge building was in a suspension bridge over the Danube canal in Vienna (300 feet span, 1828). The flat eyebars of the chains were made of puddled steel. The bridge was taken down thirty-two years later, about the time when the St. Louis arch bridge was erected,—the first bridge in which cast steel was used.

To the United States, again, belongs the credit of the first wire suspension bridge (400 feet span, 1815) over the Schuylkill river at Philadelphia. All the wire bridges of Europe were built later: namely, several smaller bridges in France, by the Seguin Brothers (1821); a small wire bridge in Geneva, Switzerland, by Colonel Dufour (1823); and the famous wire suspension bridge at Freiburg, Switzerland, by M. Chaley (1832), the longest bridge span (860 feet) on the continent to this day. Other well-known large wire suspension bridges are at Roche Bernard, France, by Le Blanc (650 feet span, 1840), and at Lorient, also in France (600 feet span).

The Suresnes bridge, at Paris, with a middle span of 260 feet and two side spans of 180 feet each, is noteworthy for its cables, composed of thin iron ribbons, which proved to be very serviceable for the purpose, but are of less strength than wire.

In the United States were built not only the first but the longest spans of wire suspension bridges. Here the greatest advance was made in their construction. The principal builders were Charles Ellet and John A. Roebling. Each engineer followed a system of his own. Charles Ellet arranged his wires in the form of strands laid side by side, with iron bars lashed across them, from which the suspenders were hung, supporting the roadway. John A. Roebling built up his wire cables into compact cylindrical form, and wrapped them with a continuous wire from end to end, thus covering the supporting

SUSPENSION BRIDGE OVER THE DANUBE AT BUDA PEST.
Built by W. T. Clarke, 1845.

wires completely. The suspenders were fastened to clamps encircling the cable. He also always cradled his cables,—*i. e.*, drew them into inclined planes for greater lateral stability,—and employed near the towers auxiliary smaller cables or ropes, called stays (not a good feature), to hold up the roadway.

The controversy and discussion between the two engineers was very animated at times, each claiming special advantages for his system. But there is no question that the Roebling system was by far the better one. One convincing test of its merits was afforded by the Wheeling suspension bridge (1,000 feet span over the Ohio river), built by Charles Ellet in 1846. Shortly after it was opened to traffic, a severe gust of wind twisted the roadway upside down, and nearly blew the bridge into the river. Roebling repaired it, and consolidated the different strands into solid inclined cables, thus making the bridge more rigid and more secure against wind-pressure.

Charles Ellet was also the builder of the first wire suspension bridge (taken down in 1854) across the Niagara chasm below the Falls. It was for this bridge that the first line across the gorge was drawn over by means of a kite, to which a heavier line, and finally the first wire, were tied that they might be pulled across. The wires were then formed into strands of his peculiar construction. To show the safety of his structure, Ellet undertook the daring feat of riding on horseback across the swaying bridge (7½ feet wide, intended only for pedestrians) before it was provided with side guards, and when no one would yet trust himself to cross it on foot.

But no one else in his day so improved the construction of wire suspension bridges as did John A. Roebling. The famous and often-described Niagara suspension railroad bridge (recently rebuilt with steel arches) was by no means his boldest attempt in that line. He planned a railroad suspension bridge of 1,230 feet span over the Kentucky river (in 1857), the construction of which was begun, but was stopped by the financial failure of the bridge company. Roebling was also the first to use the suspension bridge for supporting aqueducts, for which it is especially well adapted, because of the permanent uniform load, which requires no stiffening system. The largest bridge of this kind, and a famous one in its day, was the Allegheny suspension aqueduct at Pittsburg, Pa., of seven spans of 162 feet each. It ceased to exist in 1856. The Cincinnati and Covington bridge over the Ohio river (1,050 feet span, 1867), which has just been widened and reinforced, was the largest wire structure, until the completion of the New York and Brooklyn bridge (1869–83).

In a history of suspension bridges, Roebling's old Smithfield street bridge at Pittsburg, Pa., (1847), with eight spans of 188 feet

each, deserves mention from the fact that it sustained continuously, for more than thirty years, the heaviest street traffic ever put upon a suspension bridge. Eight-horse teams, drawing heavy castings and loads of pig iron and coal, crossed daily, subjecting the cables to a strain of more than half their capacity. The loaded span sometimes deflected two feet, the unloaded spans rising about as much. On taking down the bridge in 1882 (when it was rebuilt from my designs with a new and heavy structure of longer spans and lenticular steel trusses), the cables were cut up. The wires would curl up to the curve they had in the coil thirty-five years before. This was a most remarkable fact, showing that, in spite of the very severe strain,

CINCINNATI AND COVINGTON BRIDGE OVER THE OHIO.
Built by John A. Roebling, 1867; view taken during present reconstruction.

the wires had suffered no impairment of their original strength. They were found in very good condition, and nearly free from corrosion, although the painting of the cables had been neglected for many years. The thick paint between the cables had been an excellent preservative. The severe test to which these wire cables had been exposed proved the exceptionally durable and safe qualities of wire for bridge construction, if kept tolerably free from corrosion.

But it is also true that, wherever the wires or bars are not protected against corrosion, the structures weaken and finally collapse. Several disasters have been traced to that cause. The first prominent wire bridge to break down was the one at Angers, in 1850, under a troop of soldiers marching over it. Investigation showed that the wires were corroded near the anchorages.

Another calamitous instance was the collapse of the suspension bridge at Ostrawitza, in Austria, in 1886. The eyebars had been nearly destroyed by rust where they passed into the masonry.

There have been several instances of collapse of smaller suspension bridges in America, but none was accompanied by serious loss of life. A peculiar serio-comic mishap was the collapse of a wire rope bridge at Franklin, Pa., in which the ropes were secured at the anchorage in iron sockets filled with lead. A fire broke out in an adjacent house, the heat from which softened the lead in the rope sockets; the ropes pulled out, and the bridge dropped into the river.

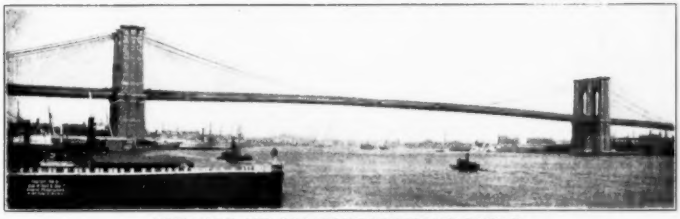
The belief that a suspension bridge cannot have the rigidity possessed by other forms of metallic bridges is still prevalent. It is, however, a mistaken belief, derived from the old, swaying, oscillating suspension bridges, which were put up as cheaply as possible, and at a time when the methods of making them rigid were not yet understood, and when no theory had been established according to which a proper stiffening system might be proportioned.

How persistent that prejudice is, even among engineers, appears from a statement, in a recently-published treatise on bridge designing by a prominent bridge engineer, that, compared with a suspension bridge, the cantilever type (known to bridge experts as the least rigid truss type) is rigidity itself. Most other engineering text-books contain similar opinions, dating from a time when very little or no provision was made for rigidity, because it was not absolutely necessary. A swaying bridge was better than no bridge at all, and, for economical reasons, heavy stiffening girders for street traffic were regarded as an unnecessary addition to the dead load, greatly increasing expense without adding to safety. The opinion of George Stephenson, from his experiments for the Britannia bridge (which was at first intended to be a suspension bridge), that, in order to make a suspension bridge as rigid as a truss bridge for railroad trains, the stiffening trusses would have to be nearly strong enough to bear the entire load, has not been endorsed by the later advanced theoretical knowledge.

Analysis of the characteristics of a suspension bridge shows that its strength depends upon three principal elements,—the cables, the towers, and the anchorages. Provided these three be strong enough, the suspension bridge is safe, though it may sway or oscillate. No other bridge can sway from any cause without imminent danger.

Theoretically, the suspended arch of a cable is in all respects equal in resisting force to the erect curve of an arch bridge. If the erect arch can be made rigid, so can the suspended arch be, and by the same methods. In the suspension bridge the arch is in tension, which must be resisted by anchorages; in the arch bridge the erect

curve is in compression, which must be resisted by abutments. But the suspended arch has the exclusive advantage of being in stable equilibrium ; it requires no lateral bracing to maintain it in position, whereas the erect arch is in unstable equilibrium, and, if not held up by vertical and lateral bracing, must collapse. Hence the greater stability and safety of the suspension bridge. It is, in fact, of all known systems the most stable and safe. In any other form of bridge, if a single supporting member be displaced or ruptured, collapse of the entire structure is the almost inevitable result. The suspension bridge, on the other hand, need not be rigid, in order to be safe. It can be designed at will of any degree of stiffness, from the mobility of a wash-line to the rigidity of a stone arch, save for slow changes os form caused by changing temperature. In a suspension



NEW YORK AND BROOKLYN SUSPENSION BRIDGE.
Commenced in 1869 by John A. Roebling; finished 1883 by Washington A. Roebling.

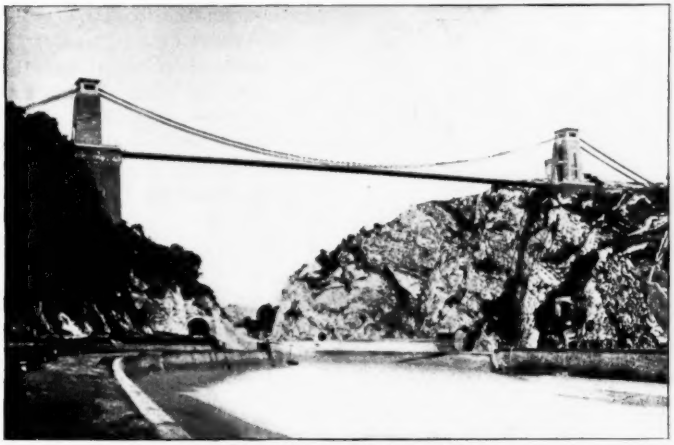
bridge the quality of rigidity is a convenience; in all other bridge systems it is a necessity. A recent occurrence on the Brooklyn bridge demonstrated this distinctive feature. The crowding of several heavily-loaded street cars on the main span overstrained the stiffening trusses in a manner perfectly intelligible and foreseen by bridge engineers. The chords gave way by buckling. The public became unnecessarily alarmed as to the safety of the bridge, which was not affected by the failure of the stiffening trusses. The bridge is designed for street traffic only, which is always more or less distributed over the entire length of the roadway, and crowding can be avoided by police regulations. If the structure had been intended for railroad traffic, or for concentrated loads, it would have had to be designed differently. Modern American railroad structures must, for instance, be able to sustain with perfect safety the load of locomotives, weighing 100 tons on a wheel base of 15 feet. If such a locomotive attempted to cross the Brooklyn bridge, it would wreck the metal floor and trusses from end to end, but the safety of the cables, towers, and anchorages would remain unimpaired. Similarly, in the old Niagara bridge, the stiffening trusses were repeatedly overstrained,

and the steel chords several times broken from the excessive load of modern locomotives and trains. Nevertheless, the traffic could be kept up with safety; the trains could not drop into the abyss because again the cables, towers, and anchorages were strong enough, and safe. If a similar buckling or breakage of bridge frame should happen on a cantilever, arch bridge, or truss bridge, then bridge, train, and all would go down without fail. And thus it is that, because a suspension bridge can safely exist without the amount of bracing which every other kind of bridge requires, it can be built lighter, as far as the superstructure is concerned. Thus, the Brooklyn bridge, which has a middle span of 1,600 feet, and flanking spans of 920 feet each, has an average dead load per lineal foot of 7,500 pounds, of which the weight of iron and steel is 6,200 pounds. It carries four rapid-transit tracks, two roadways, and a promenade, and is proportioned for a moving load of 2,000 pounds per lineal foot. With the same weight of metal (6,200 pounds per lineal foot) it is impossible to build any other kind of bridge, of the same width (85 feet), the same length of spans, and the same carrying capacity.

Compare it with the largest bridge in existence, the great Forth bridge in Scotland, which is a cantilever structure for a double-track railroad, and proportioned for a moving load of 4,000 pounds per lineal foot, which is twice the capacity of the Brooklyn bridge. The main spans are each 1,700 feet long (6 per cent. longer than that of the Brooklyn bridge). The Forth bridge contains an average of 17,000 pounds of steel per lineal foot of bridge, exclusive of the steel in the towers. That is to say, it requires 4.25 pounds of steel per lineal foot of superstructure to carry one pound of moving load, against $3\frac{1}{10}$ pounds of steel in the Brooklyn bridge required for the same service. The latter is less rigid, but, for its purpose, just as safe.

If the same weight of steel (17,000 pounds per lineal foot of superstructure) were put into a wire suspension bridge of 1,700 feet span, designed in accordance with present advanced knowledge, it could sustain a moving load of 8,000 pounds per lineal foot of bridge, which is double that of the Forth bridge and four times that of the Brooklyn bridge; moreover, it would be just as rigid as the exceptionally-strongly-braced Forth bridge, over which the fastest railroad trains pass daily, at the rate of one mile per minute.

The comparison of weights of superstructure alone would, however, be misleading in showing an economy for the improved and rigid suspension system. The cost of towers and anchorages must also be taken into account; so that the suspension type may not always be economical, particularly for shorter spans. This, however, does not affect the question of rigidity, mainly considered here.



CLIFTON BRIDGE AT BRISTOL, ENGLAND.
Commenced by Brunel, 1840; finished by Hawkshaw, 1864.

No rigid railroad suspension bridges have been built as yet. The two old suspended structures over which railroad trains passed—namely, the Niagara wire bridge, mentioned before, and the chain bridge in Vienna, built in 1860 by Schnirch—were semi-rigid, faulty in design, and too weak for the increasing loads of modern locomotives and cars. At their time no reliable theory of stiffening such structures existed. The Niagara bridge (820 feet span, single track), after being reconstructed in 1880 with steel stiffening trusses, contained only 2,000 pounds of metal per lineal foot, while the double-track arch structure (550 feet span) which replaced it last year contains 10,000 pounds of steel per lineal foot.

Any other bridge of the same span and same lightness of construction not only would have been unable to carry railroad trains across the chasm, but would have collapsed under its own weight. Nevertheless, the fact that this bridge deflected under railroad trains (about twelve inches) had been interpreted and harped upon as proving the unsuitability of the suspension type for railroads, while actually the contrary was proven. No other bridge with so little metal in it has ever done the work of that span.

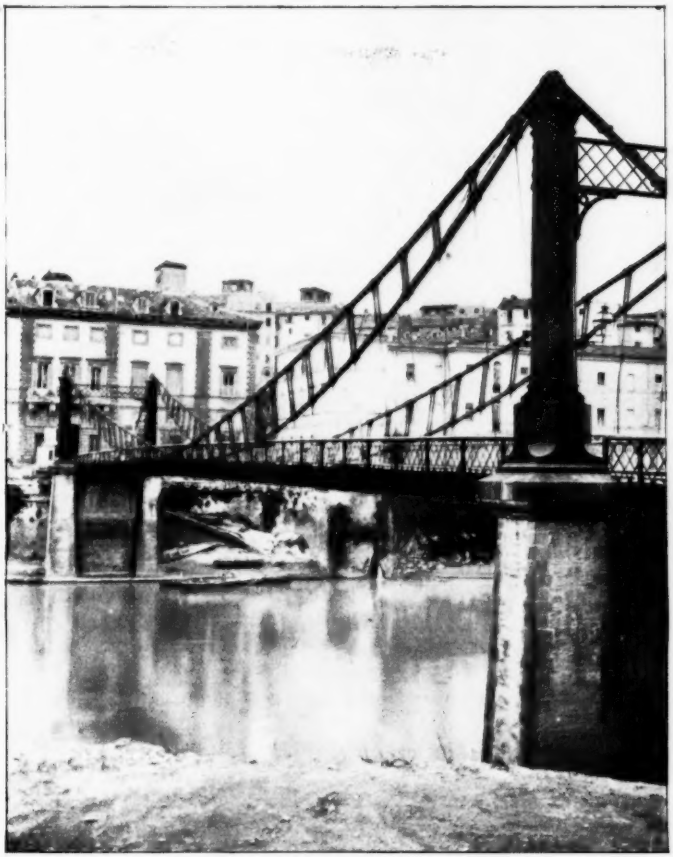
Under ordinary conditions the rigid suspension bridge, suitable for heavy railroad traffic, will show no economy over other bridge types for spans where the moving load exceeds the weight of superstructure. For semi-rigid and rigidless suspension structures no such limitation of economical spans holds good.

THE PROJECTED NORTH RIVER BRIDGE OVER THE HUDSON, AT NEW YORK. DESIGNED BY GUSTAV LINDENTHAL.

But, for the longest possible spans for any kind of traffic, the steel wire suspension bridge is the only available type. For this reason the projected railroad bridge over the North river at New York, requiring a span of 3,100 feet, will be a steel wire suspension structure; it will be as rigid as the Forth bridge. Careful calculations and estimates, made for different designs, showed in this case that the multiple-track (from six to fourteen tracks) single span of 3,100 feet will cost less than would a bridge requiring a pier in the river, for which rock bottom could be found only at a depth of 260 feet. Here the cost of the main or river span alone could not be considered without the cost of the shore spans, the length and character of which are greatly affected by local conditions, so that a combination of circumstances, producing the before-mentioned economic result, will hardly be found on any other large river or estuary.

The North River bridge will differ from, and be a great advance upon, suspension bridges as built heretofore, in almost all details of construction. To mention one feature, each of the four cables will be in the form of quadruple chains, one above the other, each chain composed of wire links connected by huge steel pins. The special advantage of this form of cable construction will be that the chain links can be made of exact length at the shop with machinery,

so that all wires will be strained alike. In this way the cables can be finished under roof, like any other steel parts of the bridge. This is not possible with wire cables of the kind used for the Brooklyn bridge, or with cables composed of wire ropes. For then the wires or ropes must be put in place one at a time, adjusted to proper length, and then compacted into a solid cable. The adjustment requires calm weather, as wind causes the wires or ropes to vibrate, and is a time-consuming operation, made more difficult in that the wires



BRIDGE OVER THE TIBER AT ROME. BUILT IN 1889.

are unequally heated by the sun. While there are no rigid railroad suspension bridges in existence, several have been built for street traffic. Among them is the Point bridge in Pittsburg (800 feet span, 1876). The stiffening system in this bridge is above the curve of the chains, in the form of segmental chords meeting at the center of the span. The bracing is between the chords and the cable.

A bridge of apparently similar construction, but still radically different in principle, is a highway bridge in Rome, built in 1889, over the Tiber. The bracing in this bridge is inserted between two chains on each side of the bridge. The chains intersect on the lines of lop-sided hyperbolas at the center of the bridge. The equilibrium

SEVENTH STREET BRIDGE OVER THE ALLEGHENY RIVER, PITTSBURG, PA.
Built by Gustav Lindenthal, 1885.

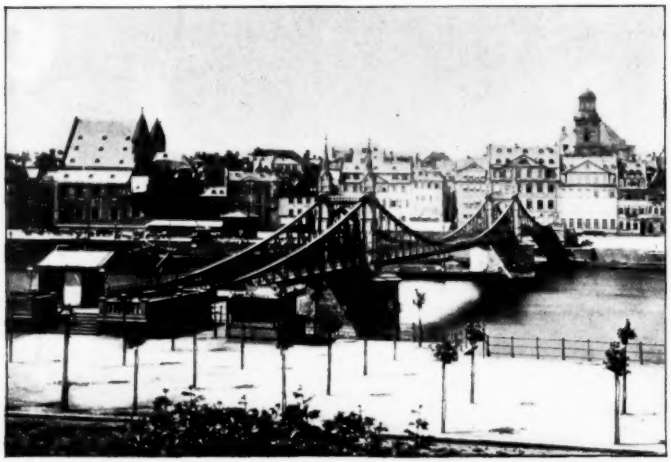
curve passes midway between the intersecting chains, both of which are designed to remain in tension from moving loads. The difference between this bridge and the Pittsburg Point bridge is that the equilibrium curve in the latter corresponds entirely with the chain.

Another stiffened suspension bridge in Pittsburg is the Seventh Street bridge over the Allegheny, for highway purposes. It has two middle spans of 330 feet each. In this bridge the uniform load is carried on each side equally, by both chains. The bracing between them serves as a stiffening system, which proved entirely adequate for the heavy street traffic.

JEFFERSON AVENUE BRIDGE, ST. LOUIS, MO.
Built by C. Gayler, 1890.

The suspension bridge at Jefferson avenue in St. Louis, built in 1890, carries a wide avenue on a 400-feet span over the railroad tracks. In this bridge the upper arch is the supporting member, formed of eyebars, and the lower arch is attached merely for stiffening purposes. The bridge is as rigid in every way as a truss bridge. The Lambeth bridge in London sustains a heavy street traffic with comparative rigidity, although the construction is not free from serious

LAMBETH BRIDGE OVER THE THAMES, LONDON.
Built by Barlow, 1862.



SUSPENSION BRIDGE OVER THE MAIN, FRANKFORT, GERMANY.
Built by Schnirch, 1869.

faults. Another example of a rigid suspension bridge is the one at Frankfort-on-the-Main,—a riveted structure carrying a footway across the river. The bridge at Loschwitz, over the Elbe, is also classed as a rigid

BRIDGE OVER THE ELBE AT LOSCHWITZ, SAXONY.
Built by Koepke, 1893.

suspension structure with riveted members, although it is combined with a cantilever feature of doubtful utility.

The new East River bridge will, in appearance, resemble the existing Brooklyn suspension bridge,—with the exception of the towers, which will be of steel,—but it will differ greatly from it in the important feature of the stiffening truss, which will have double the height of the trusses in the existing bridge, and will be of more rigid construction throughout. It is intended to carry, besides the wagon and street traffic and electrical cars, locomotive trains on two lines.

The suspension bridge system is particularly applicable to locations where rocky shores on both sides afford natural anchorages, and where the navigation interests preclude an arch bridge. The great expense of heavy masonry anchorages can then be saved.

THE NEW EAST RIVER BRIDGE BETWEEN NEW YORK AND BROOKLYN.
Designed by L. L. Buck; now in process of construction.

The facility of erection without falseworks, and the graceful architectural appearance of a suspension bridge, should give it the preference in many places where at present only truss bridges, or cantilever bridges, are thought of. For these reasons the authorities of Buda Pest have recently decided in favor of the suspension system for the new bridge which is being built over the Danube. It will be a single span of 1,000 feet over the entire river, with double chains of eyebars. It will be the longest suspension bridge in Europe, and a very handsome one,—a fitting mate to the existing suspension structure, which is world-known for its architectural beauty.

A great deal could be said of those details for suspension bridges which affect their durability, and their facility of fabrication, erection, and maintenance; for instance, whether the anchorages should be made accessible, or solidly walled in; whether the cables should be constructed of such forms that they may be readily erected, inspected, reinforced, or replaced. Some erroneous theories still prevail as regards the different systems of stiffening and the effect of temperature changes. Improvements over the old standards will certainly be made. But to deal with these questions, even in a cursory manner, would exceed the limits of this article.

THE STEEL FOUNDATION OF THE SHIP-BUILDING INDUSTRY.

By James Riley.

AT the time when the Landore Company was occupied with the execution of the first contract for the supply of the new "mild steel" to the British admiralty, there were in existence—in Great Britain at least—only three works established for the production of steel by the open-hearth process. These were the Landore Siemens Steel Company, near Swansea, South Wales; the Steel Company of Scotland (of which the writer became manager in 1878) with works at that time at Newton near Glasgow, to which they subsequently added the Blochairn Works, also near Glasgow; and the Panteg Steel Works, near Newport, Monmouthshire.

There were open-hearth furnaces at two or three other works, but these three alone were designed explicitly for the manufacture of Siemens-Martin or Siemens steel. Both the Landore and Newton works had been constructed after the plans of the late Sir Wm. Siemens, and at both it was contemplated that the principal product would be rails. The great fall in the price of rails after 1874, and the rapid and great developments and improvements of the bessemer process,—also principally directed to the production of rails,—had caused the utmost concern to those closely connected with the management of these two works, as it began to be realized that rails could not be produced as cheaply by the open-hearth as by the bessemer process. It became, therefore, a matter of vital interest that other outlets should be found for the products of the Siemens process.

In these circumstances the adoption of "mild steel" by the admiralty was of great importance, and the thorough satisfaction expressed not only with the manner in which the contract was executed, but also with the behaviour of the steel in the process of ship-building and afterwards, was of absorbing interest to the producers of open-hearth steel. Possessed of the tolerably firm vantage-ground of this undoubted success, it was determined to explore the various industries consuming iron and steel, to find outlets for the new product.

Neglecting many subsidiary—although in the aggregate important—uses to which the new material could be applied, it was apparent that it would be wanted chiefly for ship-building, boiler construction, bridge-building, and—in South Wales—the manufacture of tinplates,—iron plates coated with tin,—one of the staple industries of that part of the country. At an early stage of the period under

review the writer (then manager to the Landore Company) turned his attention to the production of steel tinplate bars, and was successful in supplying these of a quality and at a price which were more satisfactory than those of the charcoal iron bars then in universal use. As there were many works which did not manufacture their own iron bars, it was to these that application was first made, and of course it was less difficult to achieve success here than in the case of those who, producing bars for their own consumption, were naturally averse to seeing their charcoal furnaces fall into desuetude. In the end, however, there was no help for it; the latter had to follow the course adopted by the former, who had found the working of "mild steel" advantageous in many respects. Thus was initiated a revolution in the tinplate manufacture which in a very few years was complete, Siemens mild steel having totally displaced charcoal iron, and bessemer steel the commoner quality known as coke bars. The limitation here set forth, by which Siemens steel could take the place of only the charcoal iron bars,—not the common coke bars,—was that of price. The only inducement the steel-maker had it in his power to offer—quality being considered sufficiently good in either case—was that of price, which was of course ultimately governed by the cost of manufacture. From this great change has sprung the extensive Siemens steel industry of South Wales and Monmouthshire, producing annually hundreds of thousands of tons of open-hearth steel.

The limitation by cost of production, just referred to, is very significant. It was possible to produce at a lower cost a metal of equal quality—or equally suitable quality--with charcoal iron, but the Siemens steel-makers could not then—nor could the bessemer-steel-makers until some years later—produce a metal at a sufficiently low cost to compete with the coke bar from which was made the commoner quality of tinplate.

Similarly the steel-maker could not produce mild steel in the form of plates, angles, etc., to sell at the same price per ton as that at which the ordinary iron of commerce sells; consequently he had to search for other advantages to offer to users, to induce them to accept his more costly material in place of the cheaper iron. These were found, and will be referred to later; but, while fully appreciating these and urging their great value, the maker was oppressed in the early days by the necessity of reducing his costs of manufacture, so that he might compete successfully with the iron-maker and increase the demand for steel. In later days it became increasingly necessary to reduce costs, in order to maintain his position in competition with other makers of steel at home and abroad.

This necessity has been the beneficial, if unpleasant, cause of many

most important modifications and improvements in methods, processes, machinery, and apparatus, and has resulted in the tremendous development in the manufacture of mild steel which we have witnessed in the course of twenty years.

Twenty-five years ago the Siemens gas-producer and the Siemens melting furnace were *essentially* what they are to-day. They have been modified in form and in many details, but the principal changes have been in the direction of enlarged areas of melting hearth, of gas and air ports, of regenerator-chambers, and of gas and air flues and valves, and have resulted in a largely-increased output of ingots.

In the early days a melting furnace had a capacity of five or six tons and a weekly output of about fifty tons of ingots. The total consumption of fuel—a fairly good coal being used—was nearly sixteen hundred pounds to the ton of ingots produced. To-day charges of forty to fifty tons are common, and a weekly output of three hundred tons of ingots per furnace is by no means exceptional, while the consumption of fuel—now principally "slack" or "dross"—has decreased to nearly one thousand pounds per ton of ingots produced.

Consideration of the arduous labour of charging forty to fifty tons of material, and the time occupied in doing this by manual labour, have led to the construction of powerful and ingenious machines to relieve the workman of this serious tax on his physical strength, and simultaneously to economise in cost. On the "casting" side of the furnace the diminutive carriage and ladle of five to six tons' capacity has developed into the huge cauldron capable of containing fifty tons of steel in addition to a large portion of the accompanying slag. The ingot of ten or eleven hundred pounds for rolling into angles or sectional bars has grown to one of three or four thousand pounds or more, and those from which plates are produced have developed from about one ton to seven or eight tons or more.

To deal with these masses the three- or four-ton steam travelling cranes have been superseded by magnificent machines—steam, hydraulic, or electrical—capable of moving, with the greatest ease and facility, masses weighing fifteen to twenty tons and in some cases even fifty to sixty tons.

It was at first the custom to hammer the ingots, especially those to be made into plates. Originally an eight- or ten-ton hammer was used. The ingot usually weighed from two thousand to twenty-five hundred pounds, and was manipulated by a gang of six or eight men, who turned off fifteen to twenty tons of slabs daily. For larger plates ingots of three thousand to thirty-five hundred pounds were used; but to handle these with any degree of safety four additional men were required. These hammermen were a frequent cause of trouble

to managers by their insubordination and readiness to "strike" on slight pretences, and they were a class not easily replaced.

Trouble of this character, added to the desire to make heavier slabs for larger plates, led the writer to design and construct in 1884 a "slabbing," or "cogging," mill, with suitable gear for tilting the ingot, so that "work" could be put on the edges. This first mill—since universally adopted in one form or another—was made to deal with ingots of two and a half to three tons in weight; now ingots of seven tons, and not infrequently ingots of ten tons, are in use. This step in advance was of very great importance. At the mill a few men did with ease the daily work which it had required sixty men to accomplish under the steam hammer; better slabs were made, with a much smaller proportion of scrap; and, most important of all, much larger and heavier slabs were made, thus rendering possible the production of the magnificent plates now frequently called for. An incident of this progress was the evolution of the vertical furnace—either coal- or gas-fired—from the Gjers soaking pit, which had worked for many years with fair success.

The earlier plate mills had rolls about six and one-half feet long and twenty-four inches in diameter, and were capable of rolling the slabs then made into plates as large in area as any then ordinarily used. Since the advent of the slabbing mill, however, and the evolution of the slab of six or eight tons, plate mills have been increased in size, until now the largest rolls are thirteen and one-half feet long and about forty-four inches in diameter. Simultaneously it has been necessary to improve and develop all the means of handling these masses, and of shearing and finishing the large plates referred to.

Thus cursorily we have glanced at the developments in the processes and means of manufacture. It is evident that these have been very great, and have involved the expenditure not only of vast sums of money, but of a great amount of ingenuity, energy, and skill on the part of the managers. It may almost be said that, in the course of the period under review, a new professional expert has been evolved,—the metallurgical engineer. The mark of his genius, in conjunction with that of the mechanical engineer, is evident at every point. In all the various melting furnaces, with the splendid mechanical appliances used in operating them; in the magnificent rolling mills, with their feed-roller gear, screwing gear, travelling tables, and other auxiliary appliances; in the exceedingly massive and powerful shears for measuring and cutting slabs, and for shearing plates,—are evidences that the steadily-increasing demands on the skill of the engineer have been adequately met. The development of the conceptions of the metallurgist or metallurgical engineer, and the reali-

sation of his aims and ambitions, have effected a corresponding development on the part of the mechanical engineer and his means and appliances for the production of the machinery demanded by the circumstances in which both experts found themselves. In fact, the action has been reciprocal; the ideas of both have been enlarged, and both have been enabled to control forces and powers which have rendered possible operations and results undreamed of a quarter of a century ago. A measure of the development of the production of "mild steel" may be found in the following figures, which give the output of open-hearth steel ingots in Great Britain in the years stated, the very great and constant increase of this output being due to the development in the demand for "mild steel."

1877....	150,000 tons.	1887....	981,104 tons.
1878....	160,000 "	1888....	1,292,742 "
1879....	175,000 "	1889....	1,429,169 "
1880....	251,000 "	1890....	1,564,200 "
1881....	338,000 "	1891....	1,514,538 "
1882....	436,000 "	1892....	1,418,830 "
1883....	455,500 "	1893....	1,456,325 "
1884....	475,250 "	1894 ...	1,575,318 "
1885....	583,918 "	1895....	1,754,737 "
1886. ..	694,150 "	1896....	2,317,555 "
		1897....	2,601,806 "

These figures are principally taken from *The Iron & Coal Trades Review*, August 19, 1898.

The "new departure" taken by Sir N. Barnaby on behalf of the British admiralty—as previously described—has been consistently followed to the present time. The broad views that he entertained, and the very intelligent lead and encouragement that he gave to the steelmaker, have been ably seconded by his esteemed and powerful successor, Sir Wm. White. It is probably correct to say that every vessel constructed for the royal navy since that time has been built almost entirely of steel. The same may be said, of course, of vessels built for foreign governments, which have drawn on the steelmakers of Great Britain for a very large proportion of their requirements.

In some notes furnished to the writer by Sir N. Barnaby he says: "The modern ship . . . has at the same time availed itself of every advance in the improvement of iron or, or in other words, in the substitution of steel for iron. Engines are steel, boilers are steel, the hulls and the armour of the ships are steel, and so also are the guns and the projectiles. This vast change has come about since the Iris and Mercury were built for the British navy twenty years ago. The prime agent in it, Sir Wm. Siemens, is dead. The men who

were foremost in appropriating the new material and making the most of its qualities are still among us. It is to Thornycroft, Yarrow, and Normand, to Schnieder and to Krupp, that engineers and gunners are mainly indebted for the initiative in the use of steel for naval warfare."

When, however, attention is turned to the mercantile marine,—to the building of ships for the merchant navy,—other elements enter into consideration. Before there could be any great development in the use of "mild steel" in this direction, it was necessary to remove the objections, to overcome prejudices if any existed, and to satisfy the requirements of three important parties concerned therein. These were the ship owners, the ship-builders, and—perhaps most important of all—the surveying and other authorities—the committees of Lloyds Registry and of the Liverpool Underwriters' Registry, then two separate corporations, but since amalgamated.

To take the last first, it is well known that, before a vessel can be classed at "Lloyds," the plans must have had the approval of the committees; they must conform to the requirements in every detail, whether as to material, scantling, or structure. Hence the importance of the acceptance of the "new material" by these authorities, and under conditions favourable to its use. As has been shown, the admiralty had, in 1875, contracted for the material for the construction of two vessels, and in 1876 the very satisfactory results obtained were made known at the meetings of the Institution of Naval Architects. Notwithstanding these circumstances, it was not until nearly two years later that "Lloyds" announced their conclusions as to their requirements when steel was used in the construction of vessels. In the interval a committee of principal officials visited most of the steel works, inquiring into the methods of manufacture, and critically investigating the characteristics and behaviour of the metal under varying treatment and conditions. Then came the decision, which, remembering the intelligent views always held by the chief surveyor, Mr. Martel, was what might have been expected. Having regard to the admirable character of the material and its superior tensile strength, a reduction of about twenty per cent. would be allowed in the scantlings of the structure. An organisation was eventually arranged by which surveyors were to witness the testing of the steel at the maker's works, and to certify that it had met all the requirements of the committee.

The ship-builders, as a whole, were slow to adopt the new material. Possibly they had apprehensions of difficulties in its use; certainly most of them failed to realise that they had any interest in recommending it to their clients, and in most cases they were apathetic. There were several brilliant exceptions to this rule, however,—the

late Mr. Wm. Denny, the late Dr. A. C. Kirk, Mr.—now Dr.—John Inglis, the Thomsons of Clydebank fame, with Mr.—now Professor—J. H. Biles, who had been associated with the use of the material in building the Iris and Mercury and afterwards held a principal position at Clydebank. These men recognised the great possibilities which the new material opened to the naval architect, the ship-builder, and the engineer, and were insistent on its adoption and favourable treatment by the different registries. But, as has been said, the ship-builders, as a whole, were indifferent.

In these circumstances the steel-maker decided to turn to the ship-owner, to show him that his interest lay in having his ships built of steel instead of iron. In the early days very little headway was made; the disparity in the cost of the two materials was too great. Such vessels as were built were of special character and for special purposes,—the well-known Columba of the Clyde, two steamers for cross-channel service, torpedo boats, barges, and other vessels for Indian rivers, etc. When, however, the steel-maker had to some extent succeeded in reducing his cost of manufacture, and could thus sell at a price approaching more nearly that of iron; when Lloyds sanctioned the reduced scantlings, thus further reducing the total cost of the steel vessel; when it could be demonstrated that, although it might be more costly, the steel vessel was a much safer and better vessel, and that it had a larger carrying-capacity on the same displacement, and therefore a larger earning power,—then, slowly but surely, conviction entered the minds of the ship-owners, and the steel-makers' victory was in sight. It was arduous work, but it extended over only a few years. When one famous line after another—the Union Steamship Company, of New Zealand, the Pacific Company, the Allan Company, the Castle Company, the British India Company, the P. & O. Company, the Cunard Company, in the sequence here given and in the course of the years 1878 and 1879—ordered vessels of the new material, an influence was brought to bear which proved irresistible. It began to be realised that, if business connections were to be retained, and if work was to be carried on economically, vessels of the new material must be obtained.

Then also came enlightenment to the ship-builders. Soon they found themselves engaged in a movement of vast importance. They were entering upon an era of prosperity such as they had not anticipated. Not only so, but, when they began to work and use the new material, they found possibilities that promised a long continuance on the line of progress on which they had entered. They found very few of the anticipated difficulties in working steel; on the contrary, they had so few failures when compared with those they had when using

iron that both workmen and employers found it more remunerative and economical to use steel, especially in difficult work. More than this, the ship-builder, after conferring with the steel-maker, found that he could burst the bonds in which he had been held by the natural restrictions on the powers of the ironmaster. Gradually, but surely, new or larger or more economical sections were asked for and furnished, and plates of larger area and weight were produced. Whereas in the early days plates sixty feet in superficial area were looked upon as of considerable size, in these days it is possible to obtain them of quite four times that area. As these facilities gradually became available, and he developed his own machinery to deal with these larger and heavier pieces, the ship-builder found that he could largely increase his output in a given period, and diminish the cost in handling, in rivetting, and in many other directions,—in fact, could produce a vessel at a much lower cost than was possible in the old days.

The large increase in demand, and the constant effort to improve his methods of manufacture and his mechanical appliances so as to satisfy the incessant new requirements, resulted in the present advanced stage of progress, and in the ability to sell these fine products at about one-fourth the price paid in 1875 for the small sections and plates which it was then possible to supply.

But, if the ship-builder found his advantage in the use of the "new material," the marine engineer discovered possibilities in which he could fairly revel. "Cribbed, cabined, and confined" by the limitations placed upon him under the old *régime*, he could now indulge the hope of gratifying his highest aspiration, of realizing conceptions which of yore it seemed almost madness to entertain. Having at his command a material on whose good qualities he could absolutely rely, and which he could obtain in sizes hitherto undreamed of, he gradually evolved that tremendous instrument, the marine boiler of the present day. Desirous of meeting his utmost demand, the steel-maker has supplied the engineer with plates three hundred feet in area and two inches in thickness, proved of uniform and reliable character throughout. Possessed of these, the engineer has, with the utmost confidence, produced a boiler capable of enduring the highest pressures, and has thus been able to take step after step in advance,—to develop the quadruple-expansion engine after having successfully launched the triple-expansion one, and to approach very closely to his ideally-perfect, economical engine.

But in the marvellous triumphs of marine engineering of these latter days are to be found other evidences of the beneficial results of the interchange of ideas between the marine and metallurgical engineers, without which, in fact, these achievements could scarcely have been

accomplished. Very tentatively, twenty years ago, the manufacture of steel castings of the new "mild" character was commenced and carried on. With lengthened experience, confidence in his power of production was developed in the steel-founder, and in the mind of the engineer a like confidence in the use of steel castings. The demands of the engineer steadily grew in number and in difficulty, but each step in advance was carefully made and firmly held, until the steel-maker has given the engineer castings—almost equal to forgings in quality—of twenty to thirty tons in weight, of what may be called enormous dimensions, and of most intricate character. Able to obtain soleplates, columns, etc., of such magnitude and character, the contruction of engines like those of the Paris and New York, the Campania and Lucania, has been rendered possible, or at least much less difficult than would otherwise have been the case, while in other cases the number of pieces has been much reduced, the designs have been simplified, and the cost has been diminished.

	Iron.	Steel.
1877	443,015 tons	nil
1878	517,692 tons	4,470 tons
1879	470,969 tons	16,000 tons
1880	459,994 tons	35,373 tons
1881	659,153 tons	71,533 tons
1882	851,075 tons	125,841 tons
1883	933,774 tons	166,428 tons
1884	661,201 tons	132,457 tons
1885	303,825 tons	162,641 tons
1886	189,854 tons	191,399 tons
1887	94,512 tons	380,570 tons
1888	62,612 tons	687,235 tons
1889	78,609 tons	1,016,071 tons
1890	42,069 tons	957,894 tons
1891	35,846 tons	1,092,244 tons
1892	29,859 tons	1,059,001 tons
1893	7,181 tons	780,085 tons
1894	10,430 tons	893,856 tons
1895	7,789 tons	862,595 tons
1896	10,407 tons	908,304 tons
1897	9,206 tons	763,766 tons*

TONNAGES (GROSS REGISTER) OF IRON AND STEEL VESSELS BUILT UNDER SURVEY OF LLOYD'S SURVEYORS DURING THE YEARS 1877 TO 1897, INCLUSIVE.

Conjointly, then, the ship-builder and engineer have, in the end,

*Engineers' strike; 1898 will shew a large gain.

availed themselves to the fullest extent of the services of the steel-manufacturer. They have made such use of "mild steel," and it has been obtained at such prices, that it has been almost universally adopted as the best and cheapest material for the construction of ships and their boilers and engines. The rate of development in its use for this purpose may to some extent be measured by the table on the preceding page which gives the tonnages of vessels of iron and steel "classed at Lloyds" in the years named.

These figures are sufficiently startling in themselves, but they mean a great deal more than is at once evident. A new industry—the manufacture of "mild steel"—has been created, and developed to an enormous extent. This, in turn, has rendered possible the construction of the magnificent vessels of the present day, propelled at railway speeds by the marvellous modern marine engine, at the lowest cost in expenditure of fuel. In these achievements are embodied the results of active and influential interchange of ideas between the metallurgical, the marine, and the mechanical engineer, at every stage, nay, at almost every step in the progress made.

But the results do not end here. The whole social condition of the people has been improved by the abundance of employment; by the cheapening of the necessaries of life brought from the ends of the earth at costs undreamed of in the past, but rendered possible by the achievements under consideration; by the facilities and comfort of present-day travelling; and, may we not also add? by the growth—intellectual and moral—due to these improved conditions and the education of all the powers necessarily possessed by those engaged in these noble pursuits.

The development of the use of "mild steel" has not been confined to ship-building and marine engineering. In the realms of the mechanical and civil engineer it has been equally conspicuous. After the board of trade, in 1878, allowed the co-efficient of strength of steel for structural purposes to be taken at six and one-half tons, as compared with five tons for iron, its use in the construction of bridges rapidly extended, the most conspicuous example of its application being that of the Forth Bridge, rendered possible by the judicious and intelligent use of the "new material" by its eminent designers.

In view of these applications, as well as those of the builder of locomotives and rolling stock, and innumerable other requirements, it is not a matter of wonder that the manufacture of steel has developed to the extent indicated by the figures given above, justifying the sentence used at the commencement of these articles,—*viz.*, that this may be fairly called "The Age of Steel," of which the manufacture and use of "mild steel" forms a striking feature.

A SIMPLE AND EFFECTIVE SYSTEM OF SHOP COST-KEEPING.

By H. M. Norris.

THE system of accounting governing the collection, tabulation, and retention of the cost of an article of merchandise plays so important a *rôle* in the commercial organization of so many industrial enterprises that it does, indeed, seem strange that so few representative concerns are in possession of really reliable knowledge of the subject. Of all the elements which enter into and contribute toward the success of a business, the subject of cost-keeping is least understood. Systems there are galore, but how much confidence can be placed upon the figures derived from one out of ten? Every man makes use of that system which, in his judgment, seems best adapted to the needs of the establishment over which he has authority. But in matters of this nature a man's judgment is very apt to be at fault, especially if he is not a graduate from the shop. Here and there a manufacturer knows what he is doing, but the multitude are foundering in a sea of uncertainty and perplexity, from which there can be no relief until the subject receives the attention it deserves.

Mr. Henry Roland's many valuable contributions on this subject to THE ENGINEERING MAGAZINE afford a rare opportunity for the study of the practice followed by many leading firms, and contain much of interest to every one connected with shop management. His incisive drawing of the difficulties to be met and overcome in the reorganization of an old and well-established business will strike home to the hearts of many managers. If proprietors could be brought to a better understanding of what a strong organization would mean to them, the work of the manager would be much simplified.

It is the object of this paper to describe a system of cost-keeping which, for simplicity and effectiveness, meets the requirements of the shops of which I have had charge better than any other system of which I am cognizant.

There are a number of ways by which the cost of a machine, as a whole, can be obtained with a reasonable degree of accuracy, and many manufacturers are satisfied with this amount of information. But it is not enough for the progressive manager. A knowledge of the total cost of a machine is of use only in fixing the selling-price, or in taking an inventory. It is of no practical value in reducing cost. The information is too general. The foreman has no means

of detecting excessive time, except through his own observation. Tell him that a certain machine cost two hundred dollars more than the last one, and he is baffled at once. He does not know where to fix the responsibility, nor is there any way in which he can find out. It is impossible to reduce the cost of a machine to its minimum figure without first obtaining an accurate knowledge of the time consumed in the manufacture of each piece. A workman will not exert himself without an object. He must be offered some incentive. The piece-work, premium, and differential systems are conducive to this end, but should be used after, and not before, the acquisition of reliable time-records. To ally the time of one man with that of another is to halve the responsibility of each. It promotes laziness and destroys ambition, and is a practice to be avoided when possible. Every man should be permitted to make his own record, untrammeled by the time of another. Each should be paid according to his ability.

This means that it is necessary not only to keep track of the cost of each piece on a machine, but to ascertain the cost of every operation on each piece. It is, therefore, obvious that we must adopt some form of job ticket.

A separate ticket for each operation would necessitate the filling out of from one to six or more forms for each piece on the machine, —a procedure involving an immense amount of clerical labor, not only in preparing the tickets for the shop, but in collecting and tabulating the results for ready reference in the future. Hence we must find some other means of accomplishing the desired results.

The system should give three things,—the time required on each operation, the prime (or flat) cost of each piece, and the total cost of the machine as a whole. The first furnishes the necessary information for the reduction of cost, the second the means of determining the price at which repairs can be furnished, and the third the selling-price of the machine proper. The question now is: What is the cheapest, quickest, and most reliable way of obtaining this information?

The manager's desk should be the Alpha and Omega of every transaction. It should also be the information bureau of the establishment. No work should be done without the manager's authority and sanction. He should be posted in all things relative to the various stages of the work in operation, and the knowledge should be reliable and easy of access. A large plant requires a more elaborate system than does a small one, but the principle of the one is the principle of the other. In a small shop an order can be issued to its ultimate destination at once, while in a large one it may be desirable to have it pass through the hands of the works manager, superintendent, or stock clerk—a difference in detail only.

Starting, now, from the manager's desk, let us note the various objects to be attained by the system. The store keeper must receive authority to order castings and other necessary merchandise. The foreman must be notified when the material is in stock ready for the shop. The workman must have authority to remove the material from stores. The foreman must know what work has been finished, and what remains to be done. The job clerk must know what material is used on each order, the time consumed in the performance of each operation, and the total cost of each at any stage in the progress of manufacture, all of which can be accomplished by the thoughtful use of the collective job, or "piece order," ticket.

I have near my desk a board, twelve inches by twenty-two, containing twice as many pins as there are sizes and styles of machines in my line of manufacture. Two pins are used for each machine, one above the other. On these are hung poker chips of different colors, as shown in Fig. 1. When an order is issued to the shop, red chips, equal in number to the machines called for on the order, are placed on the upper pin devoted to the machine ordered, and, as each machine is completed and goes into stock, one chip is taken off and hung on the lower pin. For every order that is received, a blue chip is placed on the lower pin, which, together with a red one, is removed when the machine is shipped. If no machines of a certain kind are being made, the pins remain bare, except where the manufacture of that machine has been discontinued, in which case a white chip is hung on both the upper and the lower pin. When a pair of pins have six red chips on the upper one and three red ones and one blue one on the lower, it signifies that there are six machines in the course of erection, three in stock, and one sold, awaiting shipment.

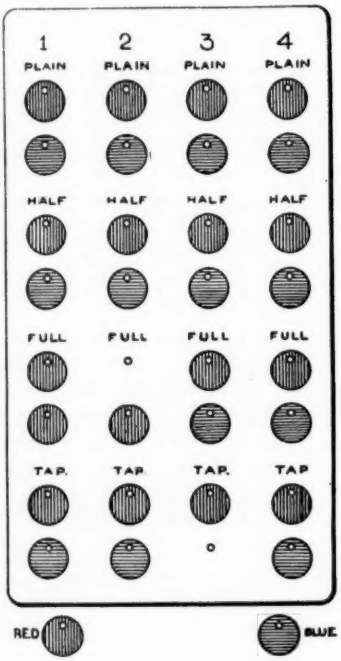


FIG. 1.

PIECE ORDER No. *3401* — *Worm Wheels.*

Shop No. *2814.* Pcs. *24.* Sym. *6A97*

Operations	Workmen's Names	No.	Commenced Mo.	Dy.	Hour	Finished Mo.	Dy.	Hour	Time Reg	Over
Bore and Turn	*Smith*	*98*	*6*	*8*	*7*	*6*	*9*	*9 30*	*12½*	
Polish	*Jones*	*23*	"	*9*	*1*	"	*9*	*2*	*1*	
Gash	*Brown*	*18*	"	*11*	*3*	"	*12*	*5*	*12*	
Hob	*Green*	*72*	"	*13*	*10*	"	*14*	*10*	*10*	
Notch	*Hill*	*52*	"	*15*	*8*	"	*16*	*3*	*16*	
								Total Time on *Order*		*51½*
								Average Time Each		*2'—8"*

Signed: *Geo. W. Hill,* Job Clerk.

MATERIAL ISSUED FROM STORES.

Symbol	Description of Material	Date		Quantity	@	Amount
6097	*120 lbs. C. I.*	*6*	*7*	*24*		

Remarks:

Material....
Wages...
Prime Cost....

READ CAREFULLY:—Upon the receipt of this order from the Drawing Office, the Stock Clerk will first note if he has in stock the full quantity of material called for on the reverse side of this blank. If on hand, he will fill out and attach a tag to one of the pieces, and will then send the order to the General Foreman in order to notify him that the material is in stock ready for the shop; otherwise he will make requisition at once for such material as is required to complete the lot, and will hold the order until the same is delivered into his care.

When the order reaches the General Foreman it should be pigeon-holed according to the class of tool by which the first operation will be performed, and should be retained by him until such time as he wishes to assign the work, when the order should be handed to a laborer with instructions to present it to the Stock Clerk, and to deliver such material as he shall receive from him to the workman to whom the work has been allotted.

The Stock Clerk will give out no material other than called for by one of these blanks, or a Stock Withdrawal Order, countersigned by the foreman, one or the other of which forms should be filled out by him as indicated above, and sent immediately to the Job Order Clerk whenever anything is removed from stores.

FIGS. 2 & 3. FACE AND REVERSE OF ORDER TO JOB CLERK.

By this means I can tell at a glance just how many machines of each kind are in stock, how many more are in building, and what number of each are sold. If I find the stock is running too low on a certain size, I issue an order to the job clerk for a new lot, who, in turn, issues as many of the piece orders shown in Fig. 2 as there are pieces on the machine,—*i. e.*, pieces upon which work is performed specially for this machine. The job clerk merely fills in the shop number, the number of pieces required to fill the order, and the symbol—pattern-mark—of the piece, the dotted line at the right being used only for irregular work having no pattern or stock number. This done, the piece orders are sent to the stock clerk, who carries out the instructions printed at the bottom of the reverse side of the ticket (Fig. 3).

In many cases the same piece is used on a number of different sizes of machines; so, in order to insure the making, at one time, of as many like pieces as will be used on the total number of machines on order, the stock clerk keeps the piece orders on file, arranged according to their symbols, card-index fashion, until such time as he receives the full quantity of material called for by all duplicate piece orders, which are then massed into one order, calling for as many pieces as were wanted for each of the other orders. In other words, if the stock clerk finds that he has two piece orders for the same part, one for six pieces and one for twelve, he holds both until he has eighteen pieces in stock, when he writes out a new piece order calling for eighteen pieces, designating how many are wanted for each shop order.

By running over the piece orders in his possession once or twice a week, the stock clerk can readily detect just what stores are needed to complete all orders in hand.

It frequently happens that, while there may be plenty of work in the shop, the foreman is at a loss to know what work to assign to the various hands as they come to him for a new job, and finds it necessary to do considerable looking around before he is able to find anything. But, by filing the piece orders according to the instruction on the backs of the tickets, this delay is entirely avoided, as he can see at a glance just what work there is to be turned, planed, milled, etc.

After each ticket has been returned to the stock clerk, and the work counted, weighed, tagged, and turned over to the shop, it is sent to the job clerk, who, after noting whether the proper entries have been made on the back, places it on file in a trough similar to the one in use in the stock room, but made in two compartments, to distinguish between the tickets in use and those partly finished but not being worked upon at the time. Here the tickets are kept ac-

cording to their piece-order numbers, instead of their symbols, as was the case in the stock room.

Now we come to that part of the system concerned with the getting of the men's time upon the tickets. I have tried four ways. The first was to have the time clerk go among the men every morning, and take such time as they gave him. The second was to have each of the men hand his time in on a slip every evening, as he quit work. The third was to have the men report to the job clerk every time they started a new job. The fourth is the plan I am now using.

No work is permitted to leave the store room without a tag (Fig. 4), which practice simplified the problem considerably, and avoided the everlasting running to the foreman to ask: "What shall I charge my time to?" The tagging did not, however, prevent errors from creeping into the figures collected by the first two methods. Unless a workman is fairly good in mental arithmetic, it is a troublesome prob-

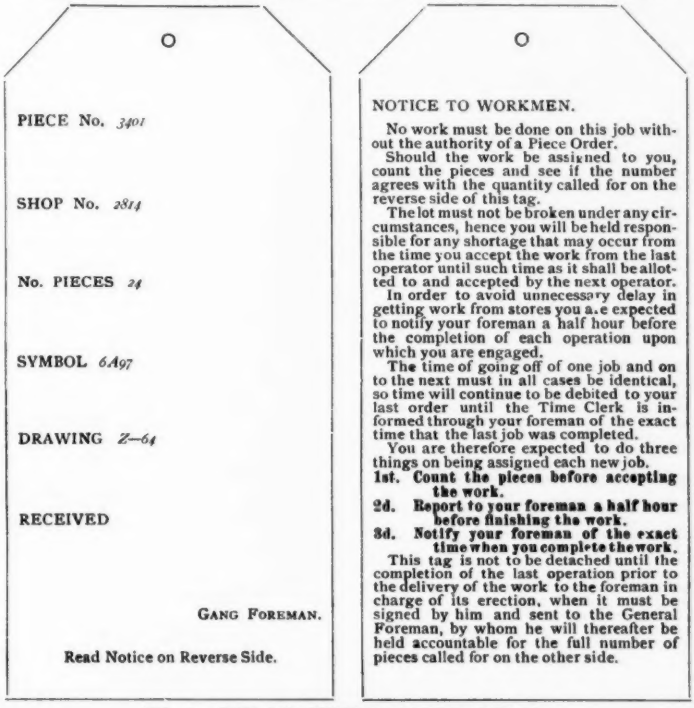

PIECE No. 3401
SHOP No. 2814
No. PIECES 24
SYMBOL 6A97
DRAWING Z—64
RECEIVED
GANG FOREMAN.
Read Notice on Reverse Side.
NOTICE TO WORKMEN.
No work must be done on this job without the authority of a Piece Order.
Should the work be assigned to you, count the pieces and see if the number agrees with the quantity called for on the reverse side of this tag.
The lot must not be broken under any circumstances, hence you will be held responsible for any shortage that may occur from the time you accept the work from the last operator until such time as it shall be allotted to and accepted by the next operator.
In order to avoid unnecessary delay in getting work from stores you are expected to notify your foreman a half hour before the completion of each operation upon which you are engaged.
The time of going off of one job and on to the next must in all cases be identical, so time will continue to be debited to your last order until the Time Clerk is informed through your foreman of the exact time that the last job was completed.
You are therefore expected to do three things on being assigned each new job.
1st. Count the pieces before accepting the work.
2d. Report to your foreman a half hour before finishing the work.
3d. Notify your foreman of the exact time when you complete the work.
This tag is not to be detached until the completion of the last operation prior to the delivery of the work to the foreman in charge of its erection, when it must be signed by him and sent to the General Foreman, by whom he will thereafter be held accountable for the full number of pieces called for on the other side.

FIG. 4. FACE AND REVERSE OF STORE-ROOM TAG.

lem for him to figure elapsed time between two given periods in the day, especially when one period is A. M. and the other P. M. and the noon-interval is a fractional part of an hour. The men not only spent a great deal of time in the calculations, but the results were not reliable. Sometimes they would forget to look at the clock to note the time of commencing a job. At another time they would get hold of the wrong order number. Again, they would juggle their time in order to hide some bad workmanship, or to guard against being "jumped on" for spending too much time on certain work. The third plan, in which all figuring is done by the job clerk, overcame most of these difficulties, and would have proved satisfactory, had we had a job clerk on each floor; but, as it was, it gave the men an opportunity of doing too much visiting while on their way up and down stairs. My fourth, and present, plan is practically the same as the third, except that, instead of having the men report to the job clerk each time they start a new job, I have them report to the department foreman, each of whom carries a pad of time-slips printed as shown in Fig. 5. These slips are used in the following manner.

Mr. *Green.* No. *72.*

STOPPED WORK ON

Piece Order No. *3401* at *10* o'ck.

To *Bore & Turn.*

The Work Called for on Ticket No. *3527.*

Wm. Peters, Foreman.

FIG. 5. TIME SLIP.

As soon as a man completes each job, he says to his foreman: "I finished the work on piece order No. 3401 at 10 o'clock." The foreman says to him: "Bore out that job of cones lying on the floor near your machine," the piece-order number of which he noted on a blank slip a half hour earlier, when the man first notified him, in accordance with the instructions on the back of the tag, that he would shortly be out of work, and prior to his sending the piece order to the stock clerk to have the castings delivered from stores. Turning to this slip, the foreman fills it out as shown in the illustration, and

both his and the man's clerical work is completed. These tickets, besides removing all time-keeping from the hands of the workmen, and accomplishing their mission so far as it relates to the time records in the office, furnish a check on the foreman, as any delay in getting work to the men will appear in the time charged against the job.

On reaching the office each morning, the slips are first assorted according to the men's numbers. Then, beginning with number one, the time is transferred to the piece orders and to the time book at the same time.

TIME SHEET.

Name of Workman, *Sam Hill.* Check No. *52.*

	Ordinary Time.									Overtime.								Total.	
Order Number	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Total.	Rate.	Amount debited to job.	Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Total.	Rate.	Amount debited to job.	Time.	Amount of wages payable.
2310	10	2					12	20	2 40												
2572		8	4			3863	12	" "	2 40												
2118			5				5	" "	1 00												
2417			1	7			8	" "	1 60												
2219				3	10	8	21	" "	4 20												
Totals	10	10	10	10	10	8	58		11 60												

Week ending *Aug. 27th, 1898.* Examined, *W. E. Cole,* Timekeeper.

FIG. 6. TIME SHEET. THE ORIGINAL HAS LINES FOR 28 ORDER NUMBERS.

This book (Fig. 6) answers a triple purpose. A separate page is used for each workman, and a separate book for each week if the shop is running over-time (for two weeks in ordinary time, when the right half of the sheet is used for ordinary time, like the left side). The totals at the bottom of the vertical columns act as a check between the sum of the hours charged each day to the whole number of tickets upon which each man has worked and the records furnished by the time clock, both of which must agree before the time is entered upon the piece orders. The small figures, 3863, near the top of the sheet show the number of the piece order upon which the man is at work, and furnish a means of checking the correctness of the entries on the time-slips. The horizontal lines show the total number of hours and amount of wages to be debited each week to the respective shop numbers, which figures are carried directly to the prime cost book, a page of which is shown in Fig. 7. This

book is merely a book of totals, and requires no explanation beyond mentioning that the numbers above and below the order number refer to the number of the page, back or forward, from or to which the number was or is carried. This completes all work connected with the gathering of the prime cost, but, before passing to the next branch of the subject, it may be well to review the entire system to this point.

PRIME COST BOOK.

Bickford Drill & Tool Co. Month of *December*, 1897.

Order Number.	Date	Drawings		Patterns	Material	Sundries	Machine Work		Total		Remarks
		Hrs	Am't	Am't	Am't	Am't	Hrs	Am't	Hrs	Am't	
Forwarded		70	28	20					70	48	
672	4	50	20	35	6		8	1 60	50	61	
	11	30	12	18	12				38	43 60	
2464	18			12	8	2	20	3 60	20	35 60	
	25				3		65	12 35	65	15 35	
684	31						80	13 60	80	13 60	
Totals		150	60	85	29	2	173	31 15	323	217 15	Finished
Forwarded											
672	4										
	11										
2465	18										
	25										
684	31										
Totals											Finished
Forwarded											
Totals											Finished

FIG. 7. REDUCTION OF ONE-HALF PAGE, PRIME-COST BOOK.

Upon receipt of my order for a lot of machines, the job clerk fills out the requisite number of piece orders. These are sent to the stock clerk, who, if he has the material on hand, forwards them at once to the general foreman. Here they are pigeon holed until the work is assigned. They are then sent back to stores, the material is issued to the shop, and the tickets are returned to the job clerk. The piece orders are thus made to accomplish seven distinct objects before being put into use as time recorders. They furnish the necessary authority to the stock clerk to order material. Their receipt by the general foreman tells him that the work is in the house, ready for assignment. Their delivery to a department foreman indicates the order in which the work is to be gotten out. Their stay in the hands of the department foreman shows him just what work he has ahead. Their return

to the stock clerk authorizes him to issue the material to the shop. Their appearance in the drawing-room shows that the work has been taken out of stores. And their location in the job clerk's file signifies whether or not the work is actually in hand. The stock clerk files them by symbol, the foreman by operation, and the job clerk by the printed piece-order numbers.

Whenever any of the foremen change a workman from one job to another, they note on their time-slip the man's name and number, the number of each piece order, the time the change was made, and the operation to be performed on the new work. These slips are left intact on their pads until the following morning, when they are sent to the job clerk, who, after assorting them by the men's numbers, transfers the time to the piece orders and to the time book, and from the latter to the prime-cost book.

By looking at the time book, the job clerk can tell what work is being done by every man in the shop, and, after a little experience, becomes so familiar with the length of time required to perform a certain operation that the workmen are likely to hear from the foreman whenever they begin to drop behind on their work.

As soon as all the operations on a piece order are completed, the tag for that work is sent to the job clerk, who abstracts the order from his working file, and places it in a permanent file where all finished orders are kept, according to their symbols. So, if he is ever in doubt about the length of time a certain job ought to take, he can turn to the symbol number, and find the record on as many pieces as have been made since the system was put into practice.

We now come to the consideration of the general expense account, the scarcity of a definite knowledge upon which subject, together with the lack of a proper and comprehensive understanding of its importance, has caused a greater number of failures in business, and more unfair competition, than can be charged to any other one factor of inefficient management. To cite a case from my own experience: I was once called to the general managership of a large and apparently-successful business. Not being familiar with the method of figuring, I asked the superintendent to make a certain estimate for me. He figured so much for labor, so much for material, fifteen per cent. for general expense, and fifteen per cent. for profit. I asked if he felt sure that fifteen per cent. would cover general expense. He answered that he was not sure, but that it was the figure used by "So and So," who had certainly been in business long enough to know what they were about. It was a month or two before I was able to collect any reliable data; but I was not surprised when I found that the general expense was more than two hundred and fifty per cent.

The company passed into the hands of a receiver two months later,—the inevitable result of doing business on a false basis.

The term "general expense" is intended to include every output, of whatever nature, that is not directly chargeable to some specific order number, and in my system comprises twenty-six distinct main charges, as shown in Fig. 8. I say *main* charges, as it is often desirable to separate one or more of the items into a number of smaller divisions, as, for instance, the item V, for perishable tools. V1 can be made to stand for drills, V2 for reamers, V3 for taps, etc. These reports are made monthly, and are the barometers of the business.

DISTRIBUTION OF PLANT CHARGES

for month of

		Hourly Burden 21½ Cts. *June*	Per Cent. Ratio 1.05 %	
Assets.	A	Standard Drawings	21	
	B	Standard Patterns	65	
	C	Standard Machinery and Tools	166	
	D	Special Tools, Jigs, and Fixtures	97	
	E	Line Shafting and Accessories	4	
	F	Office and Shop Fixtures	5	
	G	Belting	42	
	H	Miscellaneous		
		Total	400	
General Expense.	I	Advertising	399	
	J	Office Supplies	2	
	K	Traveling Expenses		
	L	Drayage, Freight, and Expressage	281	
	M	Boxing and Crating	30	
	N	Interest and Discounts	59	
	O	Bad Debts and Extras		
	P	Official Salaries	575	
	Q	Rent, Power, Taxes, and Insurance	295	
	R	Interest and Deterioration	600	
	S	Interest on New Assets	12	
	T	Patents and Royalties		
	U	Light and Heat		
	V	Perishable Tools	216	
	W	Shop Supplies	214	
	X	Drawing-Room Supplies	5	
	Y	Non-productive Labor	645	
	Z	Miscellaneous	279	
		Total	3612	
		Average daily expense for 26 days	138	92
		Total productive labor for 16800 hours	3440	

FIG. 8. DISTRIBUTION OF PLANT CHARGES.

Referring to the illustration (Fig. 8), it will be seen that, of the total amount paid out during the month, only $3,440 went into work for which there is any compensation. The return for this work must, therefore, be sufficient to cover the wages paid to producers, plus the sum of all other outlays, amounting to $3,612 = wages plus 1.05 per cent. of wages. In other words, $2.05 must be received for every dollar charged to productive labor before we so much as meet bare expenses. This, however, is not the best basis upon which to make our calculations, as it makes the charge for boys' time far too low,

and that for good men's time too high. It is much better to follow the hourly-burden plan described by the writer in Vol. XIX of the *Transactions of the American Society of Mechanical Engineers*, from which the following illustration is taken:

3 hours at .10 =	$ .30
6 " " .15 =	.90
9 " " .20 =	1.80
12 " " .25 =	3.00
30 hours	$6.00
General Expense,	6.00
Actual Cost,	$12.00

Col. 1.	Col. 2.	Col. 3.
3 × .40 = $ 1.20	.30 + 100% = $ .60	3 × .20 + .30 = $ .90
6 × .40 = 2.40	.90 + 100% = 1.80	6 × .20 + .90 = 2.10
9 × .40 = 3.60	1.80 + 100% = 3.60	9 × .20 + 1.80 = 3.60
12 × .40 = 4.80	3.00 + 100% = 6.00	12 × .20 + 3.00 = 5.40
$12.00	$12.00	$12.00

"Suppose the total charge against a certain job amounted to $6, consuming thirty hours' time as above, and that the cost of running expenses for that length of time is $6 more; then $12 is the amount which we must receive for the work, exclusive of all profit. Figuring on the old basis of a fixed charge per hour (Col. 1), we have $12 ÷ 30 = 40 cents as the rate per hour at which each item must be charged to net $12 on the job as a whole. Figuring on the basis of wages plus a certain percentage of wages (Col. 2), we have $6 ÷ $6 = 100 per cent., as the percentage by which each item of wages must be increased to meet general expense and net the $12 necessary to cover costs. Figuring, lastly, on time multiplied by the general expense per hour plus wages (Col. 3), we have $6 ÷ 30 = 20 cents as the amount per hour which must be added to each item to make the $12. Comparing the last two methods, the first being unworthy the name, we note that, while the second system of figuring accomplishes its mission so far as the ultimate results are concerned, it is manifestly inferior to the third plan, in which expenses are made on every hour of labor, irrespective of the rate per hour of the workmen, —the loss on cheap labor by the second plan not having to be made good by overcharging for the work of those requiring greater skill."

The hourly burden for any month is found by dividing the total general expense by the total number of hours charged to productive labor, which, in the report shown, amounts to twenty one and a half cents. This done, we are prepared to calculate the total cost of any order in the works. On short jobs, commenced and finished in the same month, all necessary figuring may be done on the form shown in

COST STATEMENT.

Shop No. *2468* For *Special 12-Spindle Drill.* Order No. *7829.*

Week Ending.	Drawing Room. Hours.	Drawing Room. Amount	Patterns. Amount.	Castings. Amount.	Stock. Amount.	Machine Shop. Hours.	Machine Shop. Amount.
Dec. 4	*40¾*	*12.36*					
" *11*	*8½*	*2.41*	*112.50*	*3.68*	*20.16*		
" *18*				*53.84*	*1.88*		
" *25*	*1*	*.42*		*13.70*	*125.00*	*22¾*	*3.75*
" *31*				*27.18*		*34*	*6.80*
Total	*50¾*	*15.19*	*112.50*	*98.40*	*147.04*	*56¾*	*10.55*

Drawing-Room Time,	*50¾*	General Expense,	*22.79*
Machine-Shop Time,	*56¾*	Drawings,	*15.19*
Total Time,	*106*	Patterns,	*112.50*
Hourly Burden,	*.21½*	Castings,	*98.40*
	159	Stock,	*147.04*
	212	Labor,	*10.55*
General Expense,	*22.79*	Cost,	*406.47*

Remarks: *The contract price for the above is $500.00. Profit=$93.53.*

FIG. 9. ILLUSTRATING THE USE OF THE HOURLY BURDEN.

Fig. 9, which will serve to illustrate the way in which the hourly burden is used. The interest on new assets (item S) is calculated from the assets for each month, and is taken at six per cent. for the remaining months of the year, which makes it unnecessary to change the interest and deterioration item (R) more than once a year.

The value of these reports in making an inventory will be obvious to every one. They make easy what, to most managers, is a troublesome problem. This, however, is a subject by itself, and, like other features of the system, is left for discussion in a future paper.

The advisability of making an individual tool charge is a question that every management must decide for itself. Personally, I think there is little in it, except for shops using both very heavy and very light machinery. The difficulties connected with acquiring any degree of accuracy by this method are stupendous, and the results, when obtained, afford but small compensation for the additional cost involved in the bookkeeping. Only substantially-accurate results are possible by any method of cost-keeping, as there is sure to be a more or less unfair distribution of the general expense account, the unfairness varying in accordance with the difference in value of the machines. If a firm's product consists of but one article, such as bicycle balls, the whole plant can be regarded as a single machine, without in the least affecting the accuracy of an even distribution of the general expense account; but, where a manufacturer builds a variety of lines, it is necessary to determine the hourly burden of each department separately.

THE BUILDINGS OF OXFORD, FROM AN ENGINEER'S POINT OF VIEW.

By J. W. Parry.

THOUGH there are many works on Oxford treating the beautiful buildings in the city historically, archæologically, and architecturally, as also several illustrated guides for visitors, yet the special information which an engineer requires has not been obtainable without much research and observation, consultation of well-known authorities, and deduction of conclusions. These "notes" make no attempt to fully describe any structure, nor are they intended to be "a guide" to the ordinary visitor; they refer chiefly to special characteristics, worthy of notice by an engineer or architect.*

A practical engineer arriving at a city built of stone situated on the "Oxford clay" would naturally enquire for the quarries. He would then find that the stone used in the various structures may be divided into two groups,—primitive Oxford, and modern times. Primitive Oxford, before the thirteenth century, consists of Chilswell, a rag, Wheately, a white laminated limestone, and Gibraltar, a blue magnesian limestone.

Modern times consists of Milton and Taynton, but chiefly Headington, or Heddington, from the quarries of that name two miles northeast of Oxford. This stone is divided into two strata,—an upper bed of soft oolite, which decays rapidly, and a bottom bed of compact magnesian limestone, which has been much used in New College, and, wherever adopted, has been found to last much longer than the material from the upper layer. Burford, or Bampton, is a variety of Taynton; Hincksey is a mountain limestone, like Gibraltar. In the restoration of St. Mary's spire the architect, Mr. T. Graham Jackson, has used Chipsham, from Rutlandshire. As most of the stone used in the buildings is limestone, there has been no difficulty in procuring good building lime; latterly, however, a more hydraulic lime has been ordered from Rugby.

Up to the time of the Tudors timber is mentioned in various college records as having been brought from Cumnor, Eynsham, Stowewood, Horsham, Beckley, and Shotover—a hill near Oxford. Most

* The writer begs to return his thanks to Mr. H. Hurst, of the Taylorian Institution, for his invaluable assistance, his knowledge of old Oxford being as unrivalled as his enthusiasm is boundless.

of this timber was conveyed to High Bridge during the floods, being cut in the autumn and used in the following spring. The varieties mentioned in the records are oak, elm, chestnut, ash, and beech. Some of the original timber, more than three centuries old, still exists in New College. From the time of the Stuarts logs of foreign timber were floated up the Thames to Burcot, where the remains of old landing stages still exist, and were thence carted to their destination.

The roofing material formerly used has a whitish, or bluff, look,—a schist, called in trade language Lincoln sheer slate, though it came from Stonesfield, near Woodstock. The Bangor, or Westmoreland, slates began to arrive after the canal boats were in full operation, about 1830, and have now entirely superseded the old Stonesfield schist. In 1190 a fire occurred, doing much damage to the numerous reed covered buildings; so stone and slate came into common use, instead of timber and thatch.

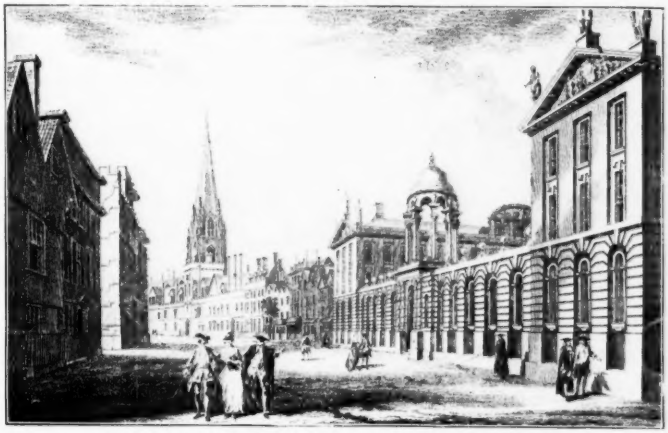
Each college is built round a quadrangle with a large entrance gateway which often rises into a quasi-tower. The rooms immediately over the gateway are invariably designed for the residence of the warden, provost, or principal of the college, so that the eye of the master may be over all who enter or leave the place. This mode of building still exists in India, being introduced into Europe by the Moors when they conquered Spain, where we find that the compound, or quad, is still used for the tethering of all kinds of animals.

Most of the colleges have been constructed on the sites of previous "Aularia," or halls, which were simply lodging-houses for students, and were pulled down to make room for the proposed college. Thus ten halls made way for New College, eight for Brasenose, five for Corpus Christi, and so on. Around the quad are arranged the chapel, library, hall or refectory, president's lodgings, buttery, and kitchen: the students' rooms generally occupy the upper floors. William of Wickham, the celebrated architect, wisely placed his taller buildings, the chapel and hall, on the north side, to keep off the cold winds, the lower buildings on the south more freely admitting sunshine.

In all cases the colleges were due to the generosity of private benefactors, the donor's wish being ratified by royal charters because opposed to the statute of mortmain. These benefactions generally took the form of rents in money, land, or both. The colleges can hold real and personal property. It is a popular delusion that the university is largely endowed by government. The royal endowments—seven in number—paid by the exchequer do not exceed £300 per annum. On account of the serious fall in land values during the last twenty-five years, the incomes of the colleges have

been much diminished; still each college employs a surveyor to look after its estates, which are situated in different counties. Until recently the college authorities had unlimited powers over the funds at their disposal. Unfortunately, these powers were not always utilised to maintain the colleges in the highest state of sanitary efficiency, according to the model by-laws. As a result, these powers were curtailed considerably by Mr. Gladstone, each college being compelled to refer sanitary matters to the local government board for orders.

As constant reference will be made to groined vaulting and hammer-beam roofs, it is necessary to remind the reader of these two structural features. The following divisions of vaulting are suggested: (1) Norman,—*i. e.*, cylindrical, either plain or crossing, with or without ribs, as in the triforium of Christ Church; (2) early English,—*i. e.*, pointed vaulting, which invariably has cross-ribs and generally diagonal ribs also, as in the choir of SS. Philip and James and the chancel of S. Peter-in-the-East; (3) pyramidal,—*i. e.*, the ribs meeting in geometrical figures; (4) late decorated, or perpendicular, in which pendants are frequently introduced, as in Christ Church choir, said to have the finest vaulting in the world, and the divinity schools, with figures in the niches. Buttresses and vaulting are intimately connected by statical laws, yet it is worthy of notice that Oxford had not a single case of a flying buttress till 1896, when the church of S. John the Evangelist at Cowley was built. This characteristic of Gothic architecture was very common in early English and perpendicular periods in many parts of England.



GENERAL VIEW OF HIGH STREET. FROM AN OLD ENGRAVING.

THE CHAPEL OF ALL SOULS, SHOWING WREN'S SUNDIAL.

It is strange that Brandon, when dealing with the open timber roofs of the middle ages, confines his remarks chiefly to those met in Norfolk and Suffolk, omitting to mention so good an example as the chapel of All Souls. The beamless roof is in keeping with Gothic architecture, lends itself to decoration or enrichment, and can be boarded under the timbers, being thus divided into panels, or "Cants," by moulded ribs, to which can be attached carved bosses at the intersections. There are three kinds of hammer-beam roofs: (*a*) those in which the walls are incapable of carrying more than the weight of the roof; (*b*) those in which the walls are firmly buttressed, unyielding, and capable of withstanding the full thrust of the roof; (*c*) those in which the wall carries a portion of the thrust—say, one-fourth. If stress diagrams are drawn for the same span under each of these modes of loading, they will be found to vary enormously; the timbers are subject to more stress in (*b*) than in (*a*), and more in (*a*) than in (*c*), and so require larger scantlings.

A peculiar device, introduced, possibly from Italy, by Messrs. Street and Drinkwater, into the churches of SS. Philip and James and S. Margaret, may be mentioned. Hooks attached to a gun-metal framework upon the impost of arches which have to bear much strain were braced together by iron bands, which were taken away when the building had settled into position.

Oxford is celebrated as a place where church bells are frequently

ringing. To the engineer and architect bell-ringing introduces a novel problem in construction and mechanics. The early towers were built some centuries before the lightest bells were cast or forged, and so were never designed for bells. Later arose the problem of setting up a framework from which to hang the bells. To introduce one end of the beam into the wall was easy enough ; to get in the other end the old builders adopted a ready and careless mode, making a curvilinear slit down the face of the opposite wall, the longitudinal timbers merely resting on the cross baulks, instead of being firmly braced to them. The result was soon apparent in cracks along the tower. A bell weighing only 500 pounds produces, at a distance of 4 feet, 2,240 foot-pounds' leverage, which is sufficient to crack the walls, especially when made of haphazard mortar. But there was another cause of vibration. The bells were hung from an upper framing supported on the main, or cross, beams ; this should have been kept free of the walls, but, instead, wooden wedges were often inserted at one or both ends, thus introducing a hammering action at another and probably weaker part of the wall. Thus the wall was subject to the action of two forces,—a leverage at the support, and a hammering action at the level of suspension. To these causes must be attributed the cracks in all towers. In Vol. II of Violet-le-Duc's architecture, sketches will be found showing the bell framing, but the author does not discuss the mechanics of the question. There is another point of great interest. If all the bells swing in one direction, then only two walls of the tower have to bear the oscillation. The designer of Merton Chapel, a well known early example, avoided this by so suspending the bells that they rang to the four points of the compass, the ringing being done from a square gallery below the bell floor. It is only within recent times that the hammering action of bells on walls has been understood, and resisted by putting tie rods, one or two inches in diameter, through the walls, heating them, and then bolting the ends, thus drawing the walls together, or, rather, preventing them from bulging.

Assume that a person walks down "The High" to Magdalen Bridge from Carfax, turning round King street and passing through the two quads of Christ Church, he arrives at "Old Tom." Suppose he then continues up S. Aldate's and Turl street into S. Giles's, afterwards retracing his steps along Broad street and Holywell. By this route he passes the colleges and churches in the following order:

I. DOWN THE HIGH. (1) All Saints Church. (2) Brasenose College. (3) Church of S. Mary the Virgin. (4) All Souls College. (5) University College. (6) Queens College. (7) Magdalen College.

II. KING STREET. (1) Merton College. (2) Corpus Christi College. (3) Oriel College.

III. S. ALDATE'S. (1) Christ Church. (2) Pembroke College. (3) S. Martin's Church, Carfax.

IV. TURL STREET. (1) Lincoln College. (2) Exeter College. (3) Jesus College.

V. S. GILES'S STREET. (1) S. John's College. (2) S. Mary Magdalen. (3) S. Michael's Church.

VI. BROAD STREET. (1) Balliol College. (2) Trinity College. (3) The old schools.

VII. HOLYWELL STREET. (1) Wadham College. (2) Hertford College. (3) New College. (4) Church of S. Peter in the East.

VIII. MISCELLANEOUS. (1) Worcester College. (2) Sheldonian theatre. (3) Radcliffe library.

There are other colleges and churches of minor importance.

All Saints Church.—This is a handsome barn with Corinthian pilasters, measuring 70 feet by 44 feet inside. It has the distinction of being the church where the right worshipful the mayor and aldermen of Oxford carry on their devotions. The "bidding prayer" on behalf of these gentry is quaint, but need not be repeated here. The tower is only 11 feet square inside, the walls being 5 feet 5 inches thick, of random rubble, and even 3 feet 9 inches thick at the belfry. Yet the mediæval spire fell in 1699; so it must have been badly designed, or else the masonry must have been so poor that the ringing of the bells cracked it. A wooden roof of 44 feet span is unusual, and, as no information could be obtained about the details of the roof, the writer determined to measure the timbers. There are nine Queen post trusses, the end ones being 10 feet 6 inches and 12 feet 6 inches, respectively, from the walls, while the others are alternately 7 feet 2 inches and 7 feet 11 inches apart. The tie beams are of solid oak scarfed and clamped, the width varying from 10½ to 12 inches and the depth from 15 to 18 inches. A few beams only are 18 inches deep, the greater number being 16 inches. There is no straining sill, and the distance, centre to centre, of straining beam and tie beam is 11 feet 9 inches. The rafters, struts, and posts consist of solid timbers. For the roof, dated 1706, Queen Anne supplied the oak. The beams carry a heavy stucco ceiling. In the *Building World* the writer asked the following questions, but has not received any replies.

(1) What weight does each beam carry, and how much could it carry? Is the latter as much as seventeen tons?

(2) Can other instances be given of wooden tie beams spanning 44 feet? If so, where?

ALL SAINTS CHURCH.

(3) In some college record it is vaguely stated that chestnut timber was supplied for the roof. Could this timber be employed for beams? If so, for what spans? Or is its use restricted to small scantlings?

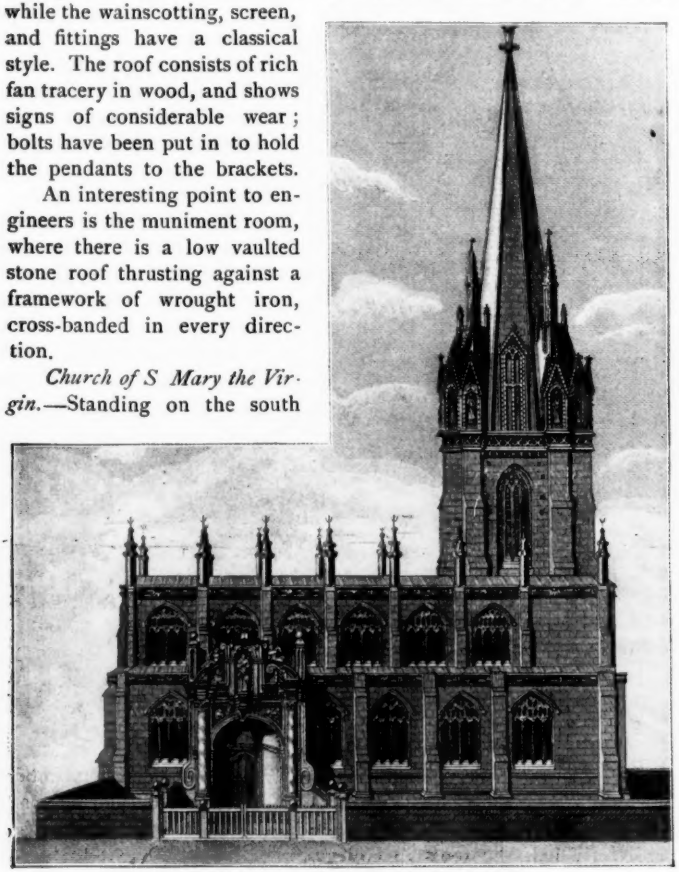
Nearly half the roofs in college buildings are thought to be of chestnut (the edible variety), this timber having much of the "figuring" of oak,- a good deal of rigidity combined with lightness.

Brasenose College.—The present extension of the college premises, with the gateway into the High, was not finished till 1890. The original and usual entrance is opposite the Radcliffe library. Eight halls were merged in this college, which was founded in 1509. The old gateway is handsome, but the entrance to High street might have been made more imposing.

The chapel is interesting as being one of the few structures built during the Commonwealth. The roof and windows are Gothic, while the wainscotting, screen, and fittings have a classical style. The roof consists of rich fan tracery in wood, and shows signs of considerable wear; bolts have been put in to hold the pendants to the brackets.

An interesting point to engineers is the muniment room, where there is a low vaulted stone roof thrusting against a framework of wrought iron, cross-banded in every direction.

Church of S Mary the Virgin.—Standing on the south



SOUTH VIEW OF S. MARY'S, OR UNIVERSITY, CHURCH.
Where is the Chancel 68 ft. long?

side of the High, one notices the beauty of "S. Mary's Clusters," as they have been happily called. The decorated pinnacles of the tower, with canopied niches full of statuary, are justly admired. Each angle of the tower is flanked by a double buttress consisting of six stages, which gradually diminish as they rise, being united above by an open parapet of trefoil work which surrounds the base of the spire. The top of the spire is 189 feet above the ground,—the same height as that of the spire of Salisbury Cathedral. The stability of the tower and spire has given rise to an interesting question in mechanics between Prof. Case of Merton and the architect, Mr. Graham Jackson, which will be dealt with further on. Meanwhile the trained eye of an engineer or professional man will at once detect that the parapet over the roof of nave and chancel is not of similar design, nor does it run in a horizontal course, there being a drop of 18 inches at one point. The difference in style, in windows, buttresses, parapets, and cornices, is very striking. The porch, with its twisted columns, arrests the attention of the most casual observer. The only similar columns the writer has ever seen are those at the grand altar in S. Peter's at Rome, which are solid malachite, polished, and were presented to the pope by one of the czars of Russia. The idea of spiral ornamentation was not new, being supposed to have an eastern origin, but the moulding of an entire shaft into a spiral was one of the multitudinous whims of the seventeenth century.

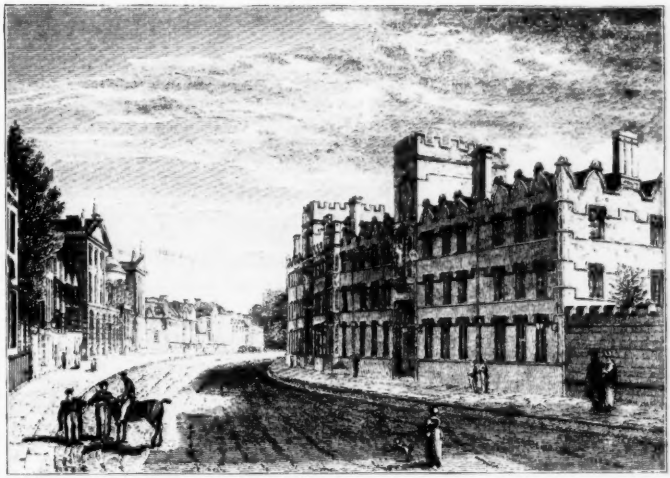
GATEWAY OF S. MARY'S.

The nave of S. Mary's is 94 feet by 54 feet, including the aisles, and 70 feet high. The chancel is 68 feet by 24 feet. Distinct chapels and chantries formed S. Mary's, all of which are obliterated. The old congregation house was the chancel of an old church up to 1200, and still exists, at a lower level than that of the present chancel and nave. This congregation

house was for the use of all the scholars of the University, and here was kept the University chest, with five keys, to hold the pledges for money borrowed from *alma mater*.

Now to the interesting dispute between Prof. Case, of Corpus Christi College, and Mr. Jackson, about the stability of the spire. Mr. Jackson's reports can be found scattered in the *University Gazettes* from 1889 to 1896. Prof. Case has published a small book, while Mr. Jackson has also written a handsome volume on S. Mary's

INTERIOR OF THE CHURCH OF S. MARY THE VIRGIN.



FRONT OF UNIVERSITY COLLEGE.

Clusters, totally ignoring, however, the vexed question. It appears that in March, 1889, some crockets and finials began to fall down, and Mr. Jackson was called upon to make a report. On erecting a scaffold, he found that most of the stone of the steeple and the pediments of the gablets had been formed of raking beds, and were in danger of slipping off, and also that a large mass of masonry might go through the roof of the nave. In addition, he found that the parapets and pinnacles of the nave and some of the north aisle, though re-erected in 1862, were completely decayed or in danger of falling. His estimate for repairs was as follows:

Southwest pinnacle	£1892
The other three pinnacles and sides	5555
Pierced parapet, round top of tower, and springing of spire	215
Tie rods and repairs	227
	£7889
Scaffolding and making good	800
Clearing up, etc	44
	£8733
Nave parapets and pinnacles	1207
Other items	1693
Total	£11,633

From various causes the cost has steadily increased, till more than twice the amount originally intended has been paid for restoration. The writer has had the privilege of talking with Prof. Case, and believes that his views may be correctly represented as follows. The Hebdominal Council, not being satisfied with the explanation given by Mr. Jackson, under the guidance of Prof. Case drew up a set of questions for the architect to answer. These questions are too numerous to detail here, but they may be epitomised thus:

THE WESTERN SIDE OF ALL SOULS COLLEGE.

A. Questions calling for dimensions of tower and deflection of spire; also the state of the four piers on which the tower rests.

B. Questions about pinnacles.—Does the mass of masonry 5¾ feet by 6¾ feet by 28 feet rest on tower or press on spire? What weight is required to resist the thrust of the spire? Does not this mass of masonry weaken the tower, especially at the northwest corner, where the tower once sank?

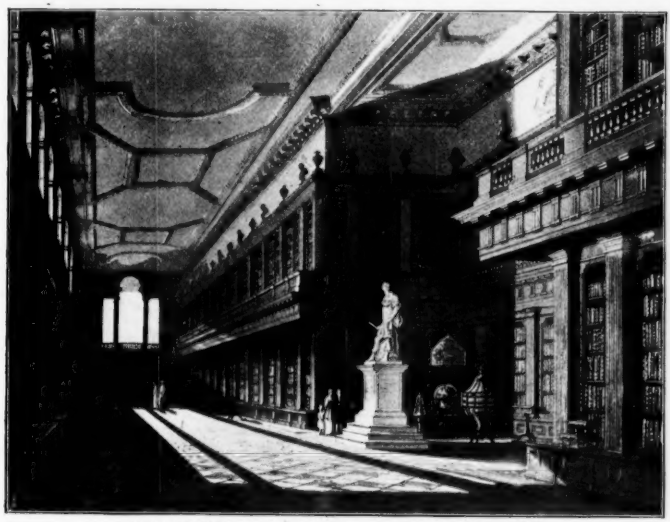
Mr. Jackson gave his replies to these questions, the most important answer being that there was no lateral thrust of the spire, as it was built in horizontal courses. The Hebdominal Council, still unsatisfied, called in as an expert Mr. (now Sir) Wolfe Barry, late president of the Institution of Civil Engineers. He caused bells to be rung from the tower, and found no distortion. He also agreed with the architect that there was no lateral thrust of the spire. It is apparent that the architect has put two bands of copper round the spire, and the cornice shown in Loggan and Turner's drawings has not been reproduced by Mr. Jackson. As far as one could gather, Prof. Case

would have liked the architect to pull down the whole of the tower as well as the spire, as he considers that the former is in a state of unstable equilibrium and that the tower, with spire, may collapse at any time.

All Souls College.—The account-books of this college are in an excellent state of preservation, from which we are enabled to get a correct idea of the wages paid about A. D. 1438. Carpenters and sawyers got 6d. a day; daubers, 5d.; stone diggers and labourers, 4½d.; masons and joiners, 8d.; a master carpenter, 3s. 4d. a week, enjoying also a tithe from each labourer employed under him,—a custom still existing in many parts of India, and which the engineers there are trying to abolish. A skilled image-carver received 4s. 8d. a week, with bed and board, as he generally came from a distance. In those halcyon days a horse cost the modest sum of £3.

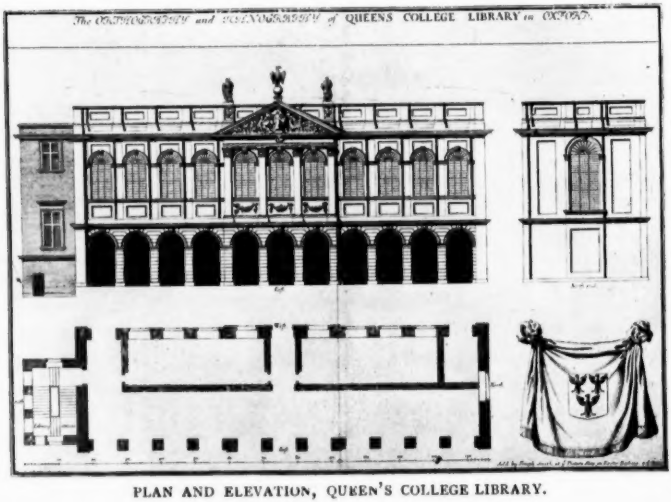
Attention is called in some books "to the exquisite vaulting of fan tracery work" in the narrow entrance to the chapel, where there is a stoup for holy water. The writer considers the tracery ordinary; there could have been no constructive difficulty, as the passage is only a yard wide. The reredos, with its delicate carving, is much admired; it is copied from that in New College. The crypt under the chancel is not mentioned in any of the usual guide-books, and few people have even heard of it.

In the northern quad are the twin towers, which distinguish All



THE LIBRARY OF ALL SOULS. BY ACKERMAN, 1814.

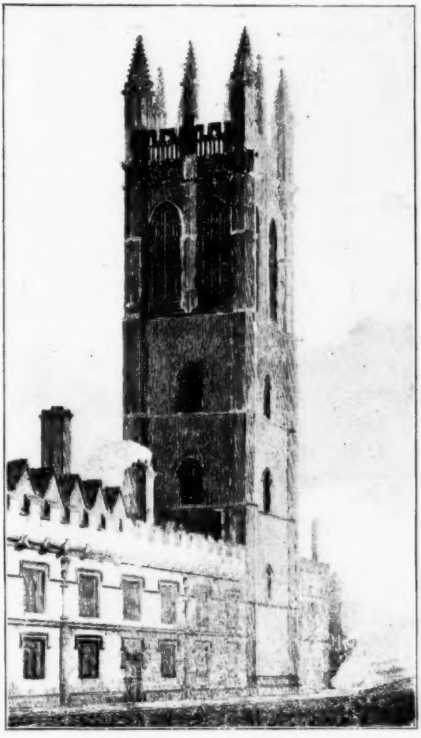
HALL OF UNIVERSITY COLLEGE.



PLAN AND ELEVATION, QUEEN'S COLLEGE LIBRARY.

Souls from any other similar institution, and Hawksmoor's diminishing turrets, with a modern arcade. The present library, shown in the engraving on page 409, is a fine room 200 feet in length by 30 feet in width, and 40 feet high.

University College.—This has one of the longest façades in Oxford, there being two gateways with two quads, each gateway having a richly-groined vault of similar design. The ground plan of the eastern gateway is very much out of the square,—clearly so intended, though the motive is not easily guessed. Probably this is due to the bend of the High street, which occurs just here.

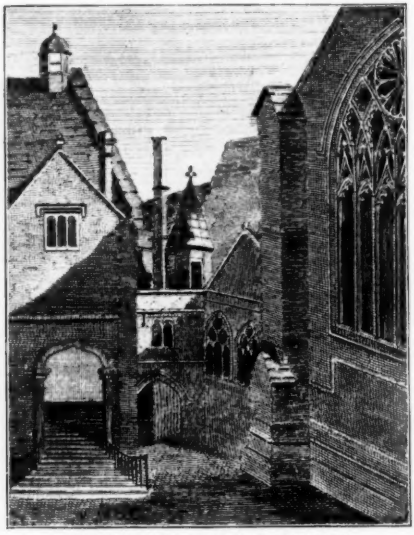


TOWER OF MAGDALEN COLLEGE.

The wainscotting round the chapel altar is of cedar; the rest, of foreign oak. There is some delicate carving in the screen, and a curious copy of Salvator Mundi, burned in wood by Dr. Griffiths. The monuments are of chaste design, especially that of Sir William Jones, the chief justice of Bengal, by Flaxman. The college is chiefly visited for the Shelley Memorial, which is placed in a glazed alcove.

Queen's College.—This building can at once be recognised by the cupola over the gateway, within which is a statue of Queen Caroline, consort of George III.

The hall and chapel of the college are opposite the entrance to the quad, the former on the left and the latter on the right. The chapel is chiefly remarkable for being Doric without and Corinthian



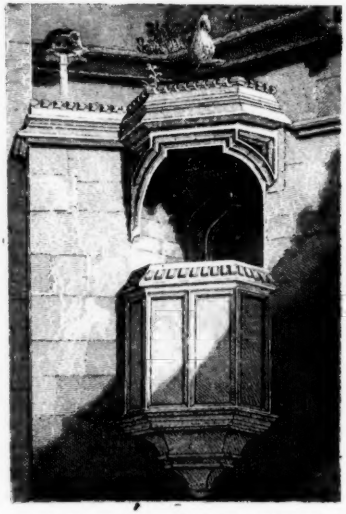
ENTRANCE TO MAGDALEN COLLEGE.

over the hall and church, with the embattlements of those buildings and the library."

On entering through the porter's lodge every one notices, at the northwest angle of an ancient oratory, the curious pulpit of stone erected by Waynflete for open-air service. Certain Parisian abbeys are said to have similar out-door pulpits. We also have records of two others at Oxford; unfortunately both have disappeared.

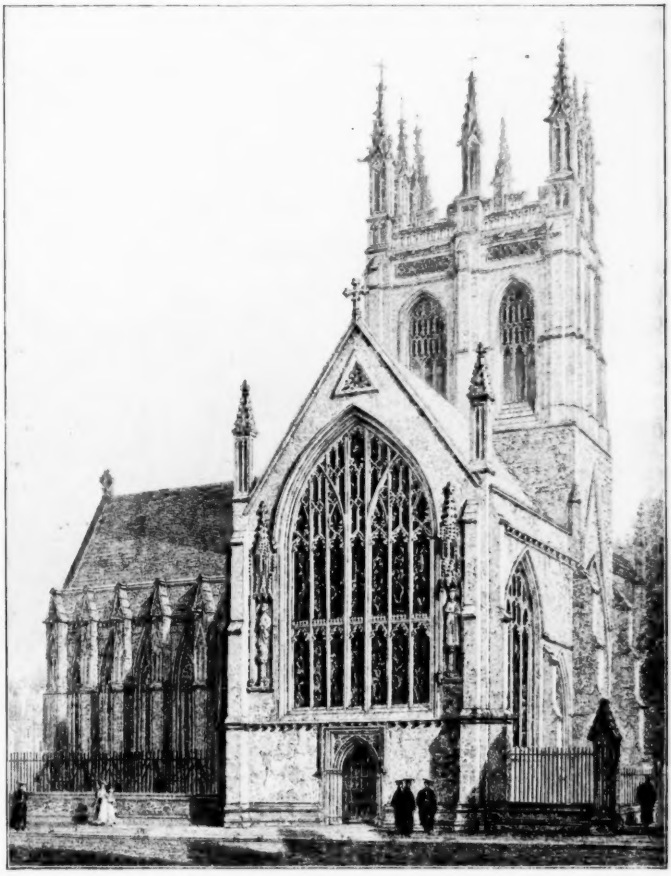
Of the chapel the records say that "few edifices in Oxford probably have experienced so many vicissitudes, and yet have retained so much of the original character." The Puritans smashed the glass and statuary, within. The hall is plain, but lofty. The queen's concert takes place in this hall yearly.

Magdalen College.—This college is well known all the world over, and the writer is particularly interested in it, as it was built on the site of a hospital on a small island formed by the Cherwell, called Parry's or Paris' isle. Contract documents for many of its parts exist, signed by a master mason 1475–1479—for instance, specification "for the spire of stone to be in altitude from the corbel table sixteen feet; pinnacles of stone



ANCIENT PULPIT, MAGDALEN COLLEGE.

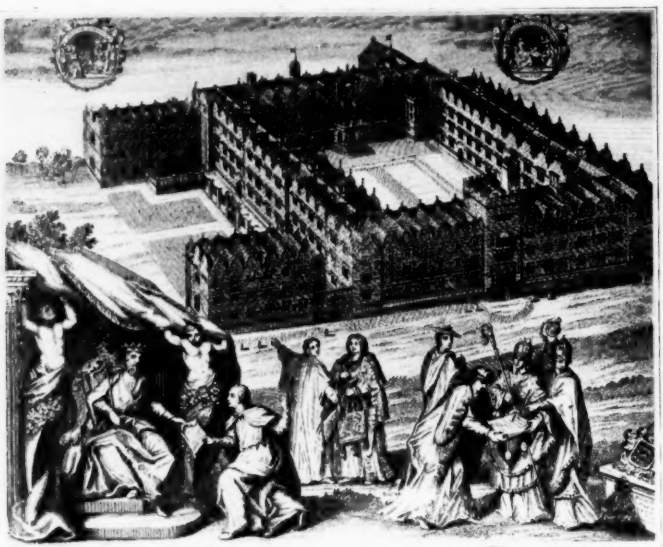
and took away the organ to Hampton Court. The present roof of the chapel is stucco, but the earlier one which it replaces had open trusses of timber carved and moulded inside, like that of All Souls Chapel. The west window, in *chiaroscuro*, has a handsome effect; the chapel, hall, and part of the cloisters formed the original design.



MERTON COLLEGE CHAPEL.
From the South West.

On the north side, beyond the cloisters, there is a large block of buildings which might have been intended for barracks or a prison, as the architect has put no elegance into his design. The view of Magdalen Bridge and tower and up The High from the Iffley road has always been justly admired, but it is a pity that the tower, which is 145 feet in height, is built on so low ground that it loses much of its impressiveness.

Merton College.—Ingram states that seventeen or eighteen halls were merged to form this college, whereas the documents refer to only ten or eleven and a water mill. In some of the halls lectures were given, while in others trades were carried on. The founder obtained



ORIEL COLLEGE. FROM AN OLD ENGRAVING.
The figures on the left represent Edward II and Adam de Brun.

three charters, one of which is of interest, as it shows an intention to bring the water of the Cherwell through S. John's Hospital (now Magdalen College). But how would the surveyor have crossed the deep city ditch? Would he have done so by a syphon? and did they know how to take levels in those days?

Opposite the entrance is a flight of steps leading to the hall. The doorway, with its hammered iron work, is a grand example of genuine

forging of fourteenth-century origin, worthy any smith's inspection. On passing the archway on the left it will be seen that the signs of the zodiac are cut on the bosses; beyond, in the quad, is a tower, ornamented with reliefs showing the four orders of architecture—Doric, Ionic, Corinthian, and Tuscan. Above the "Mob" quad is an octagonal turret enclosing a stone staircase leading to the treasury. The roof is ashlar (not slate), supported on three circular ribs. Externally the gables have the appearance of equilateral triangles. Here we have an early example of a fire-proof building, as good as any that could be constructed in modern times.

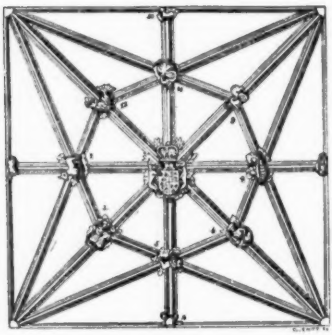
THE LIBRARY, MERTON COLLEGE.

The chapel consists of a choir (1277), transepts, and tower, the transept forming the ante-chapel. These ante-chapels are a marked feature of Oxford churches, there being neither nave or aisles. The base of the tower is 33 feet by 22 feet inside; above, the corners are corbelled out and a gallery erected, from which the eight bells are rung.

This is a most unusual device, as bells are generally rung from a floor. The position of the bells is so admirably arranged that the vibrations are in opposite directions, the result being, of course, the effective counterbalancing of any oscillation tending to bulge out the walls.

The sacristy is an excellent example of what can be done in restoring a ruined building, and much credit is due to Mr. Graham Jackson, the architect.

Corpus Christi College.—On entering, the eye is at once arrested by a cylindrical shaft, called Turner's monument, with nine sun-dials



SIGNS OF THE ZODIAC, FROM ARCHWAY IN MERTON COLLEGE.

and perpetual calendar—the only one of its kind in Oxford. It is necessary to ascend some steps to reach the library, which is part of the nave of the chapel, being separated by a gallery pew. The timber roof of the hall is of massive black oak, being an excellent specimen of sixteenth-century work.

Oriel College.—The characteristic feature of this college is the half octagonal porch. The roof of the hall has a glazed louvre, or lantern, which is unusual for the halls of Oxford, though more common in those of Cambridge. These louvres were intended as an exit for the smoke in the days when there were no chimneys, a curb of stone being provided in the centre of the room to prevent the logs from rolling.

THE EXTENSION OF SUBMARINE TELEGRAPHY IN A QUARTER-CENTURY.

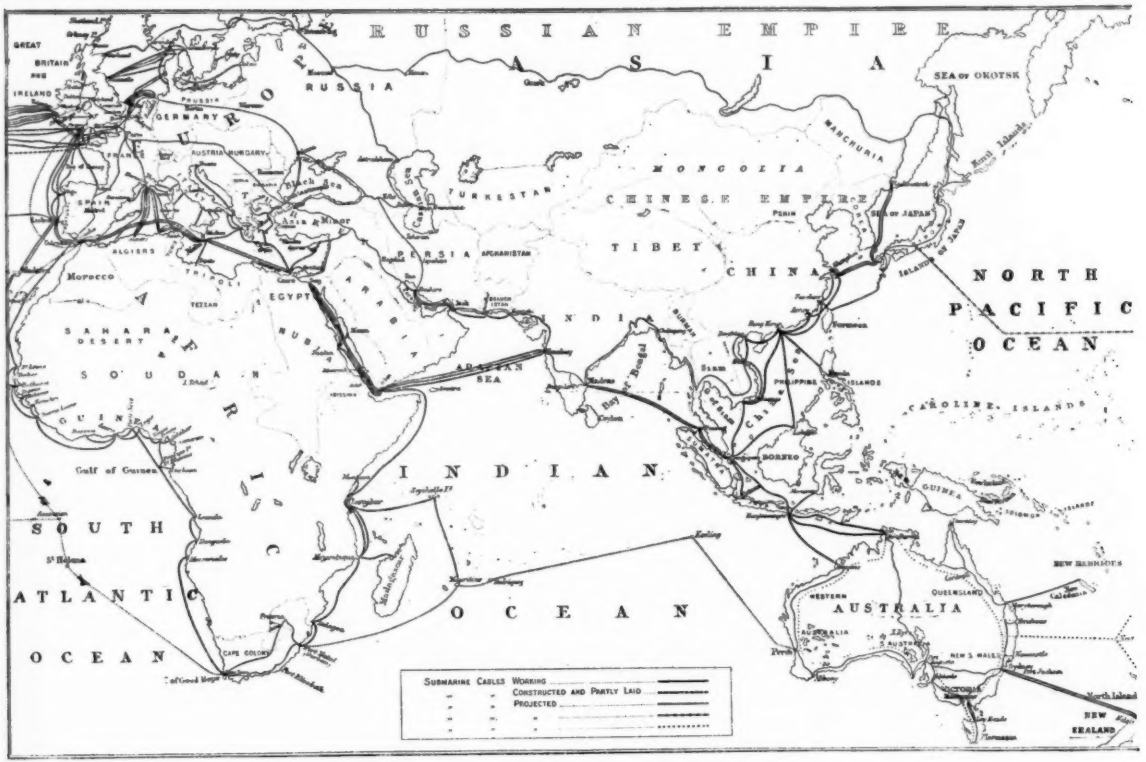
By Charles Bright.

THE last few decades have been characterised by a development and advance of engineering methods and achievements which, in the mechanic arts, is astounding, and, in almost the entire range of electrical engineering, is absolutely revolutionary.

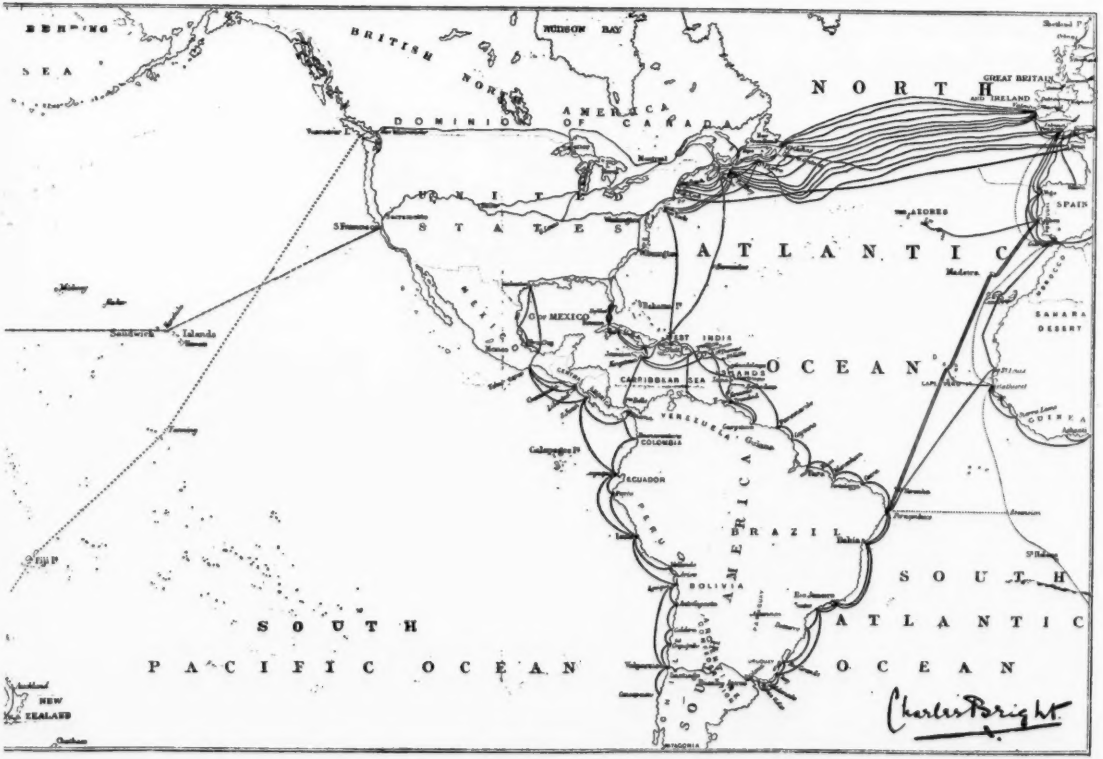
Unlike other applications of electricity, however, telegraphy, as now in vogue, was almost entirely worked out twenty-five years ago. Its laws had been laid down, and most of the pioneering done. The cable is the same; the instruments employed to work it are the same. Nevertheless, steady progress has been made, due partly to improvement in materials and their preparation, partly to improvement in details, partly to commercial enterprise and expansion.

Confining the review to telegraphy, as practiced in lines deposited in the depths of the sea, we may make the following summary of the condition as it existed twenty-five years ago. The Atlantic ocean had been spanned more than once. England was in telegraphic communication with the European continent through a number of cables to various points. The United Kingdom had established a double touch, telegraphically, with Egypt and India *viâ* the Mediterranean, Red sea, Persian gulf, and Arabian sea. Extensions reached to Australia, China, and Japan. The West Indian islands were linked with the American and European continents.

About this time, a number of amalgamations occurred in connection with some of the more important systems. All the work summarised had been accomplished during the peculiarly busy telegraphic period characterising the end of the seventh decade, and beginning of the eighth decade, of this century. It is to be remarked that scarcely any of the companies which ordered the construction and submersion of these lines, and which worked them (or are still working them) to the great benefit of the world's commerce, were assisted by any government monopolies, subsidies, or guarantees. It may truly be maintained, therefore, that the governments and mercantile communities of the world owe the vast benefits they have reaped from direct submarine telegraphic communication almost entirely to the enterprise of a few enthusiastic individuals and the original shareholders in these companies. Another point deserving incidental notice is that most of the later of these undertakings had been set afoot in England soon after the passing of the telegraph purchase bill. The promoters



CABLE CHART OF THE WORLD. THE EASTERN HEMISPHERE.



CABLE CHART OF THE WORLD. THE WESTERN HEMISPHERE.
Placed to the right of the chart on the page above, this makes a complete cable map of the world.

rightly calculated that this afforded an opportunity of securing for new telegraphic ventures a good deal of the capital let loose by the winding-up of the Magnetic, Electric, United Kingdom, Reuter, and other telegraphic companies, which had, up to that time, shared among them the control of the land-lines of Great Britain and Ireland. This acquisition of land telegraphs by the State liberated something like £8,000,000 sterling for re-investment by those who looked favourably on electric telegraphs as a subject of safe and sure remuneration. Moreover, the publicity which the proceedings of the parliamentary commission, appointed in connection with the government purchase scheme, gave to the lucrative nature of telegraphic enterprises generally, together with the previous success of the Atlantic cable in deep water, emboldened financiers and capitalists to make fresh investments of the same character.* Twenty-five years ago some 51,000 nautical miles of cable had been laid. At present upwards of 167,000 nautical miles are resting at the bottom of the sea. This review is concerned with the 116,000 for which the intervening twenty-five years is responsible.

In January, 1873, a scheme was set afloat for establishing telegraphic communication between England and Brazil and the rest of the South American continent and West Indian islands in a more direct manner than by the existing route.

The following year this system and further extensions of it were carried out. The above cables were made and laid for the Brazilian Submarine, Western & Brazilian,† and other companies by the Telegraph Construction and Maintenance Company, by Messrs. Hooper, by Siemens Bros., and by Mr. W. T. Henley. While the bed of the south Atlantic was thus experiencing changes, a new line was also in contemplation for the north Atlantic. This, under the auspices of the Direct United States Cable Company, was the first competitor of the Anglo-American system. It was planned as a direct line, not to touch at Newfoundland; but it was found that, with the core

* Former shareholders in the Magnetic Company were especially predisposed to take a pecuniary interest in submarine telegraphy, in virtue of their connection with the early Atlantic lines.

† In 1895 the Western & Brazilian Company promoted an extension of its system up the Amazon river, and a company called the Amazon Telegraph Company was formed with this object. The cables for this new company were laid last year by Messrs. Siemens Brothers. The line extends from Pará to Manáos, nearly half-way up the great river, in the heart of Brazil and the plains of the Amazon. There are sixteen stations on the line altogether, its total length being more than 1,300 N.M. This cable is expected to further develop a large india-rubber, coffee, and sugar trade. All previous attempts at telegraphic communication by means of land-lines had proved unsuccessful, owing to the rapidity and density of forest growths in this part of the world. Indeed, in the case of the cable, the new experience of laying one up an immense river whose bed is subject to very considerable and frequent changes has in itself turned out a formidable business ever since the line was completed.

determined on, the working speed would not be sufficient, and the cable was eventually taken ashore at Halifax, Nova Scotia. This was the first really big cable contract entirely carried out by the firm of Siemens, and it was executed with complete success.

In the same year (1874) the India Rubber, Gutta Percha and Telegraph Works Company, of Silvertown, laid a cable for the Direct Spanish Telegraph Company between Marseilles and Barcelona, thus extending its system to France, and thereby constituting a kind of Anglo-Spanish connection with the Eastern systems, of which now, since 1885, it forms an offshoot. The telegraphic communication of Spain with the east, as well as with the rest of the European continent, was now doubly secured.

In 1876 the original West Coast of America Telegraph Company was incorporated. Its objects were to purchase and work cables on the coasts of Chili and Peru, as well as to put the latter into communication with the Western & Brazilian system, and then with Europe, by means of the land-line of the Transandine Telegraph Company and the River Plate and Platino-Brazilian cables. This West Coast of America Company's cables had been made by the Silvertown Company, and were laid by the same firm in seven sections during 1875 and 1876. The greater part was submerged previous to the actual formation of the West Coast Company—probably the only case of its kind. The company itself was originally constituted almost entirely of, and by, shareholders in the Silvertown Company; but subsequently, in 1877, it underwent reconstruction, and has become closely identified with the Eastern and its allied companies.*

A period of calm in the further extension of marine telegraphy now supervened, lasting until 1879. In that year the Eastern and South African Telegraphy Company was launched under the financial auspices of the Eastern group. Its purpose was to establish and maintain telegraphic communication between Aden (where it would connect with the Eastern company's system) and the Cape of Good Hope, by means of a series of cables down the east coast of Africa, joining, at Port Natal, a government land-line to Cape Town, which had been completed in 1878.† These cables were manufactured by the Telegraph Construction Company, and laid by them in 1879. Their combined length was as much as 3,900 N. M., one section alone—that from Aden to Zanzibar—measuring 1,915 N. M.

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* The West Coast of America Company's system has since been extended by the establishment of land-line communications with fresh points in the interior, the most important town so connected being Santiago, in 1889.

† The sea-bottom round the Cape is not at all favourable for a cable. Moreover, the land lines,—completed and harmonised in one system the previous year,—as worked by the Cape and Natal government telegraph departments, had proved thoroughly efficient and reliable.

The same (Eastern & South African) company has since placed one of the Seychelles Islands, as well as the important colony and naval station of Mauritius, in telegraphic communication with the rest of the world. This extension, joining its system at Zanzibar, was carried out for the company (by the Telegraph Construction and Maintenance Company again) in 1893. Another extension—down the lower part of the west coast of Africa to the Cape, being in other respects a continuation of the West African Company's system—will be referred to further on.

In 1879 another French company was formed to establish independent communication between France and the rest of the European continent on the one hand, and the United States on the other. The somewhat cumbersome title of this concern was La Compagnie Française du Télégraphe de Paris à New York ; but it soon became known as the P. Q. company, M. Pouyer-Quertier being the presiding genius. The cable was made and laid in the same year by Messrs. Siemens Brothers. This line afterwards joined the pool. In 1894, however, it was amalgamated with another company of French origin under the title of La Compagnie Française des Câbles Télégraphiques. Since this amalgamation it has withdrawn from the Joint-Purse.

In 1881 an American company was established, under the guidance of the late Mr. Jay Gould, entitled the American Telegraph and Cable Company, with a view to partaking in the profits of transatlantic telegraphy by establishing another line of communication between the United States and Great Britain, and thence to the east of Europe. This cable was also constructed and laid (in the course of that year) by Messrs. Siemens Brothers, who were part promoters of the enterprise, as well as another cable for the same system in the following year (1882). This company's cables work in connection with—are, in fact, leased by—the Western Union Telegraph Company, which was practically Jay Gould's property, and remained so almost to the close of his life. In 1883 the above system entered the pool—the happy destination for which, may be, it was originally launched.

In 1880 the Mexican Telegraph Company was formed by a body of American capitalists, and in the following year the Central & South American Telegraph Company was floated by similar hands. The object of these two schemes was to bring Mexico and the west coast of South and Central America into direct communication with the United States (*i. e.*, independent of the West Indian islands), thus also diverting through the United States part of the aforesaid traffic with Europe. The cables across the Gulf of Mexico were laid between 1880 and 1882, and those for the Central and South American Company along the west coast in 1882. The latter started from Peru, at

the spot where the system of the West Coast of America Company ended, touching at Panama and various points of communication, and extending to the gulf of Tehuantepec. By means of a land-line across the isthmus of the same name, and a short cable on the other side, connection was made with the Mexican Company's cables at Vera Cruz. The Silvertown Company contracted for the manufacture and submersion of all these cables, those on the Pacific side comprising eight sections, with a total length of 3,200 N. M.

The Central and South American Company has within recent years (in 1891) extended its system to Valparaiso, and thence by land-line to Santiago, thus entering into competition with the West Coast of America Company. It purchased at the same time the Transandine Telegraph Company's land-line from Valparaiso and Santiago to Buenos Ayres (with its four intermediate stations), thus securing an independent connection of its own with the great Argentine and Uruguayan capitals, Buenos Ayres and Montevideo. By other land-lines through Brazil it also reaches Rio. This (Central and South American) company's connection with Europe is, however, exclusively by way of the Mexican Company's system, the Western Union land-lines, and the Atlantic cables to England and France.

In response to this move on the part of the American group, the West Coast of America, the Western & Brazilian, and the Brazilian Submarine Companies joined forces to promote another company in the following year for erecting a new land-line across the continent in their own interests. It is entitled the Pacific & European Telegraph Company. The construction of the required line followed soon after, along a route rather to the north of the Central and South American Company's, but connecting the same points with one intermediate station. This line was open for traffic in March, 1894.

In 1883 the Spanish National Telegraph Company came into existence. This company (with subsidies from the Spanish government) was founded to create and maintain telegraphic communication between Spain and her possessions, the Canary Islands, as well as to effect—by the help of another subsidy from the French government—an extension from the Canaries, thus connecting the European continent with the French colony of Senegal, west coast of Africa. The first part of the enterprise was carried out in the same year, and the second in 1884. The first part of this company's system, connecting Spain with the various Canary islands, was taken over in 1893, after ten years' working (according to the original agreement) by the Spanish government. The system in its entirety now forms a connecting link with continental Europe and England for the South American Cable Company's system which it joins at St. Louis, Senegal.

Two more African cable companies were registered in the latter part of 1885,—namely, the West African Telegraph Company, in September, and the African Direct Telegraph Company, in December. The former was promoted by the Silvertown Company, and was to work in connection with the Spanish National Company's system; the latter was an offspring of the Eastern group. These two companies had each obtained subsidies or guarantees from the various European governments—French, Portuguese, and British—to whom belong the different colonies at which it was proposed that the cables should touch, going along the west coast and including St. Jago and St. Vincent. The West African Company's cables were made and laid for them by the Silvertown people in the course of two expeditions, during 1885 and 1886. Starting from the southern terminus of the Spanish National at St. Louis, Senegal, this system extends to St. Paul de Loanda, serving eleven stations on the way, mostly situated in the Bight of Benin, where alone it can be said that cables behave better than men. The African Direct system was made and laid, about the same time, by the Telegraph Construction and Maintenance Company. Through the instrumentality of the two sections between the west coast of Africa (at Bathurst) and St. Jago and St. Vincent, this company secured its own communications with Europe *via* the Brazilian Submarine Company's lines to Lisbon, and thence by the Eastern Company's direct cable to England. Two years after this, the Eastern & South African Telegraph Company determined to extend its East Coast of Africa system by a cable from Cape Town, *via* Mossamedes and Benguela, to Loanda, the southern terminus of the West African Company's system. Going south, the first of the two sections—that between Loanda and Benguela—was made and laid by the Silvertown Company, and the other by the Telegraph Construction Company. Communication was thus completed, in 1889, along the whole west coast of Africa down to Cape Town. These three systems comprise nearly 8,000 miles of cable. It was now arranged that the West African Company and its cables should be taken over by the Eastern promoters, so as to constitute, with the African Direct and the Eastern and Southern African,—and for their mutual benefit,—one working system of alternative communications with the Cape. Each of the stations served by these three systems has an opportunity of transmitting, on the combined system, any messages it may have, at stated times during the day.

In the field of Atlantic telegraphy, a fresh competitor arrived in 1884,—the Commercial Cable Company. Two cables were laid across the Atlantic for this company in that year, its promoters foreseeing that, in view of the continual chance of a breakdown, only

in this way could they safely attempt to compete with more firmly-established rivals. The Commercial Company was mainly promoted by two American millionaires, Mr. J. W. Mackay, the celebrated New York financier, and Mr. James Gordon Bennett, proprietor of the *New York Herald*, with whom were associated the Messrs. Siemens, who became afterwards the contractors for the enterprise. These cables, like the Jay Gould lines, stretch from the United States —one of them from New York—to Nova Scotia, and thence to the extreme southwest point of Ireland (which is connected by special cable with England). The system is directly connected with that of the Canadian Pacific Railroad Company, thus affording ready communication with the Dominion.

Neither the Commercial Company's system or that of the Compagnie Française des Câbles Télégraphiques is at present in the Atlantic pool; they, in fact, are the two exceptions referred to.

In 1886 the Italian government entered into a contract with Società Pirelli, of Milan, for the construction and maintenance of a number of cables—about 700 nautical miles in all—to connect various islands in the Adriatic and Mediterranean seas with the mainland, chiefly for military and naval purposes. For the execution of this contract the Società Pirelli built a cable-sheathing factory at Spezia, and a telegraph ship—the "Cittá di Milano"—in England, Messrs. Johnson & Phillips supplying the machinery for both. The core was made at the Milan works, and sheathed at those of Spezia.

Down to nine or ten years ago the French had not troubled themselves much about cables to their colonies or foreign parts, and the few they had felt necessary they got made and laid for them by English hands. Latterly, however, they have concluded to render themselves more independent of British lines of telegraphic communication, and with this object have commenced in earnest the work of making and laying cables on their own account. Thus in 1887 the French minister of posts and telegraphs signed a contract for the subvention of an extensive system of cables to connect the French colonies in the West Indies with French Guiana, communicating at Cuba with the United States and Atlantic systems, and at Viseu, in Brazil, with the Brazilian land-lines to Rio and Buenos Ayres. A change of government led to the rejection of this contract by the chamber of deputies. Subsequently, however (between 1887 and 1888), a part of this scheme was carried out—as far as La Guayra, Venezuela. The cables were constructed by W. T. Henley's Telegraph Works Company,* which also contracted for the laying of

* Half the required core, however, was made at the Bezons Works of La Société Générale des Téléphones. This was the first order that firm had obtained for submarine-cable core, and the result was exceedingly satisfactory.

them. Mr. R. E. Peake (of Messrs. Clark, Forde & Taylor) executed the latter part of the contract for Henley's, while Mr. W. S. Seaton acted as engineer on behalf of the proprietors, La Participation des Câbles des Antilles. In 1888 La Société Française des Télégraphes Sous-Marins was formed, to take over the above cables and extend them as soon as the chamber of deputies should ratify the contracts made with various ministers of posts and telegraphs. In 1889 the necessary ratification was obtained. Accordingly the society proceeded to enter into contracts with the Société Generale des Téléphones for the construction in France of the said extension cables. The cables were manufactured with complete success,—partly by the Société Française des Télégraphes Sous-Marins and partly by the Henley Company,—and were laid for the "Société Française" by Mr. W. S. Seaton between 1890 and 1891.

The Halifax & Bermudas Cable Company was formed in 1889, to give effect to a contract with her majesty's government for laying a cable and maintaining telegraphic communication between the two important naval stations designated in its title. This contract has been, and is, carried out under a government subsidy of twenty-years' duration. The manufacture and submersion of this cable were given to Henley's Company, on whose behalf Captain A. W. Stiffe (formerly of the late Indian navy, and prominently connected with the first Persian gulf cables) was engineer in charge of the expedition. It passes through water as deep as 2,824 fathoms,—one of the greatest depths in which any cable is known to lie. The object of this telegraphic connection was imperial rather than commercial. It forms part of a scheme recommended by a royal commission in 1884 to provide a means of communication between the British West Indies and the mother country, passing entirely through British territory. As the line connects with several Anglo-Atlantic cables at Halifax, the direct communication demanded by the commission has been effectually established.

In 1891 the French government invited tenders for two cables to connect Marseilles with Oran and Tunis respectively. For the first time in the history of submarine telegraphy British contractors were excluded altogether. The Oran cable was allotted to La Société Generale des Téléphones, and the Tunis one to M. Grammont. The Oran cable (the core of which was turned out at Bezons, while the sheathing was applied at Calais) was laid by Mr. W. S. Seaton on behalf of the French contractors, under the inspection of M. E. Wünschendorff, the government engineer.

M. Grammont retained the services of a civil engineer and compatriot, M. Peltier, for laying the Tunis cable. He chartered the

Telegraph Construction Company's T. S. S. Calabria for this purpose, and availed himself of the assistance of some of the latter company's staff. For the manufacture of this cable, M. Grammont erected a factory (core and sheathing) at St. Topez, near Toulon.

In 1891 the South American Cable Company was promoted by those interested in the Silvertown business (India-rubber, Gutta-Percha, and Telegraph Works Company), the objects of which were to form an extension of the Spanish National Company's system on the one hand, and, on the other, an alternative competing line for the Brazilo European traffic. This was to be effected by means of a cable between Senegal, west coast of Africa, and Brazil. The cable was constructed and laid the following year by the Silvertown Company. It extends from St. Louis, Senegal, to Pernambuco, Brazil, and touches at the island of Fernando de Noronha *en route*. The last section (about 350 nautical miles in length) was furnished with india-rubber core, instead of gutta-percha, the locality being considered a suitable one for giving india-rubber a fresh trial. The main part of this line passes through one of the greatest depths in which any cable actually rests,—*i.e.*, 2,830 fathoms, lat. 9° 53′ N., and long. 21° 24′ W. At Pernambuco this company's Africo-American system meets that of the Western & Brazilian, and also that of the Brazilian government land lines, thus gaining access (by agreement) to all the principal Brazilian towns as well as to the rest of the South American continent.

In 1893 the Europe and Azores Telegraph Company was established to effect telegraphic communication between Lisbon and the Azores group. This company is worked on a subsidy from the Portuguese government; indeed, the cable is almost exclusively a Portuguese national affair, the company simply acting as government agents in the matter. It was laid for them by the Telegraph Construction Company in the same year, and connected two of the islands, Fayal and San Miguel, with one another and with Lisbon.

In 1894 two more additions were made to the list of Atlantic cables—one on behalf of the Commercial Cable Company, and the other for the Anglo-American Company. The new Commercial line was constructed and laid by Messrs. Siemens Brothers, and the Anglo cable by the Telegraph Construction Company. Special arrangements were made, in the design of both these cables, to meet the requirements of increased speed. Since the successful application to submarine cables of various modifications of Wheatstone's automatic transmitter (intended only for land telegraphy), the limit to the speed attainable depends, practically speaking, only upon the type of cable employed. In a general way, therefore, it will be readily understood

that, if funds are available at the time for the construction of one cable which will do the work of two, a notable economy is the result. On these principles, the core of the new Commercial cable was composed of a copper conductor weighing 500 pounds per nautical mile, covered with a gutta-percha insulating sheath weighing 320 pounds per nautical mile, while the new Anglo has a core with conductor weighing 650 pounds per nautical mile, and gutta-percha insulator weighing 450 pounds per nautical mile, involving a completed cable (main type) nearly double the weight of previous corresponding lines. The actual speed (simplex) obtained by automatic transmission with the latter cable is as high as forty-seven (or even up to fifty) five-letter words per minute. On the previous lighter Atlantic cores twenty-five to twenty-eight words per minute was the usual maximum speed attainable; the former, say, by average manual transmission and average receiving, and the latter by automatic transmission.

As a part of the union between the old world and the new, there are altogether fifteen cables at the bottom of the north Atlantic. Out of these, eleven are now working, all of which have been laid since 1872. Yet another Atlantic cable from France to the United States is now being laid at the instigation of the French, and with the assistance of the Silvertown's Company's ships and staff.

Two distinct lines, one of which is duplicated, now unite Europe (directly) with the South American continent and all its branch lines, thus indirectly giving additional lines of communication with the West Indies and North America.

A noteworthy void is observable in the north Atlantic, between the Azores and Bermuda, which, if filled, would constitute another Atlantic cable, and thus an additional highway between Europe, on the one hand, and the United States and Canada on the other. A still greater blank occurs between Mauritius and Australia, which might profitably be made good, so as to create an extra line to the latter country. Another useful extension would be that of the Central and South American cables up to San Francisco. How soon the greatest gap of all—namely, that across the Pacific ocean—will be spanned it is impossible to predict, but there seems every probability of a new line of communication being established by the pioneer allied telegraph companies more directly with the Cape and hence on to Australia. It is proposed that this line should touch only British territory. The above scheme should meet all political requirements, besides affording every security within reason.

It remains to be said only that far more capital is at present invested in submarine telegraphy than in any other branch of electrical industry, amounting to some forty-five millions sterling.

THE APPLICATION OF ELECTRIC POWER TO PUMPING MACHINERY.

By S. H. Bunnell.

ONE of the most salient characteristics of the times is the extension of labor-saving methods throughout the entire range of human activity—the emancipation of manual labor from the drudgery of the ordinary tasks of life and industry. Among these, the pumping of water is by no means the least, and it has attracted its full share of attention. The ancient inventor first increased his possible lift by fastening his rude bucket to a sweep, with a counterbalance. As he learned the use of animal power, he attached his buckets to the rim of a wheel to secure continuous action. As the sprocket chain is a derived form of gear, so the chain pump is derived from the rude scoop-wheel. It is impossible to enumerate the various forms of ancient pumps; but the reciprocating piston pump was early conceived, and has monopolized most of the pumping of the world to this day. To these two ancient forms, we must add two rather modern ones—the rotary-gear pump, employing specially-shaped gear-teeth to move the water, and the marvellously simple centrifugal pump.

These four classes cover nearly all the pumps in use for every purpose. The chain pump is employed only to a limited extent, and is generally worked by hand. The rotary-gear pump is used where the rotary feature combined with positive action is valuable, efficiency being of secondary importance,—as in pumping oil to flood metal-cutting tools, or in fire service by an ingenious and well-known form of fire-engine. The other types are of far wider application, and divide the field, the centrifugal pump being used where the head is low and efficiency not of the highest importance, and the reciprocating taking all other cases.

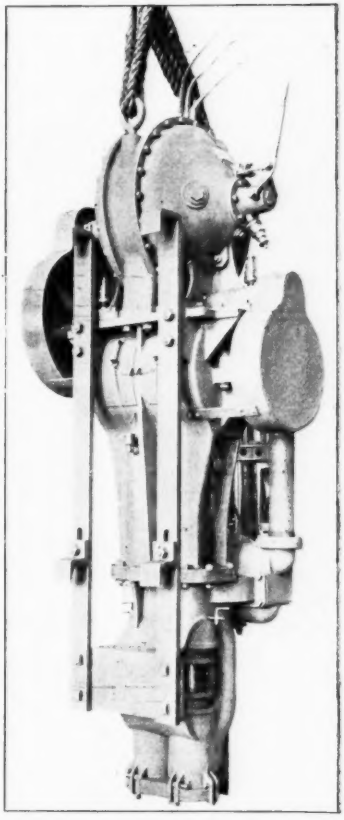
The term "power-pump" seems the opposite of "hand-pump"; but, as a matter of fact, this term is restricted to a pump driven by a rotating shaft, and is used in distinction to "steam-pump" or "pumping-engine," which consist of steam-engine and pump in one framing. Wherever conditions require the use of motive power other than steam directly applied, the power-pump is employed. It is the purpose of this article to point out a few of the conditions under which electricity is the most desirable motive power, and to discuss, from the purchaser's point of view, the advantages of some of the types of pumps especially designed to be electrically driven.

It is the custom among a certain class of engineers to condemn unsparingly the small direct-acting steam-pump as the acme of wastefulness. While undeniably the consumption of steam in these machines is large, if measured by the performance of high-duty expansive steam-engines, yet, if they are properly credited with their convenience, compactness, reliability, durability, cheapness, and, in short, their general fitness for the service intended, their disappearance seems a long way off. There are, however, certain conditions under which the power-pump has the advantage. In the effort to attain greater economy in driving small machines, it is becoming the custom to locate a large prime mover in some suitable place, and to transmit its power by proper means to the driven machinery, thus deriving the benefit of using energy developed by large prime-movers under the best conditions. It is in such cases that the power-pump is used ; and, while belt-transmission from a line-shaft is convenient, where possible, and compressed-air has a wide field of its own, electricity presents certain advantages over any other connecting link from power-plant to small machines.

The electrically-driven power-pump is generally desirable where one or more of the following conditions exists: first, where the use of steam direct would be more expensive, or objectionable; second, where electric energy is being generated for other purposes; third, where electric energy can be cheaply purchased.

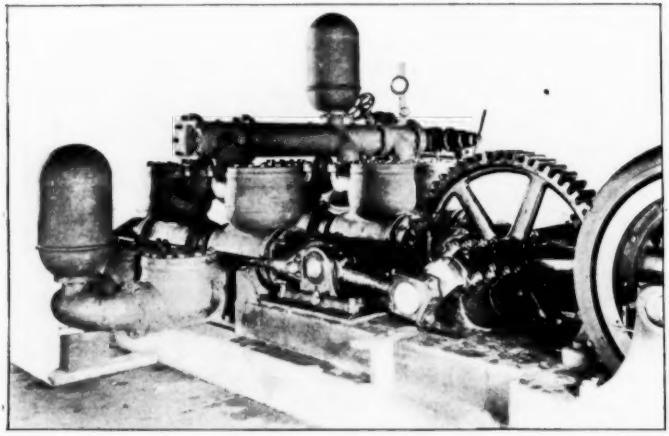
Under the first condition fall places remote from fuel-supply, or difficult of access, but where convenient water-powers exist, which, at a reasonable outlay, may be developed, and employed through power-transmission to do the necessary work at the desired point. The greater the distance between motor and work, the more does electricity possess advantages in convenience and cheapness of application and economy of operation over rope-driving or transmission by compressed air. If difficulty of access hinders the bringing of coal to boilers, it may be possible to place the boilers at a point more convenient to the fuel-supply and to transmit the power, as from the supposed water-fall. This might be done in a very hilly location, or along navigable waters, where one handling of fuel would be saved. Pumping in mines sometimes falls under this first condition; badly-planned and neglected steam-pipes often deliver more water than steam to the pumps, and, by dripping from leaks, cause decay of wood-work around them. Here electricity and compressed air present certain advantages over steam; but, except that the exhaust from compressed-air motors assists the ventilation of the room containing the machinery, there is nothing to be said in favor of the use of air that does not apply with greater force to electricity. In the case

of stationary pumps, wires take less room than pipes, and are much less liable to derangement, while for temporary track or sinking pumps, the convenience and rapidity with which the wire connections may be made are of great advantage. There are many situations above ground, where the same conditions operate to suggest the use of electric motors, and where compressed air cannot offer its capacity as a ventilator as a reason for its use.

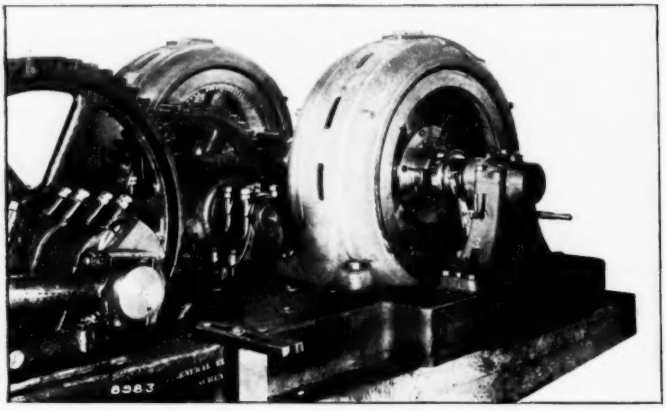


KNOWLES 5 X 6 DUPLEX SINKING-PUMP, WITH 20-H.P. GENERAL ELECTRIC INDUCTION MOTOR; PACHUCA, MEXICO.

Under the second condition falls the necessary pumping in electric-light and -power stations, where large and efficient engines are in use to drive the dynamos. Here electric-power pumps have no competitor. For the auxiliary pumps of such steam plants they are peculiarly suited. A single machine with several cylinders may be used for several services at one and the same time, thus perhaps concentrating all the pumping at one point, where it can be easily regulated. In places where there are line-shafts, belted pumps may be preferred; but few modern power-houses employ line-shafts. Large city buildings having private lighting-plants may use with advantage electric pumps for their water supply and for elevator-service, the hydraulic elevator being still in the lead of the direct electric, though possibly soon to give way. There are also factories with generators in use, metallurgical and chemical establishments using electric processes, and extensive plants with electric transmissions between buildings, where current for the operation of pumps is at hand, and where quietness, compactness, efficiency, and reliability are strong arguments in favor of this type.

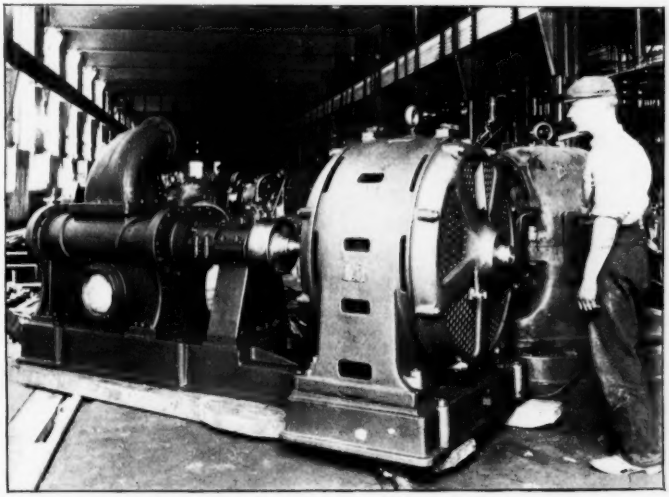


Falling under the third condition are some very small and some very large pumping plants. Pumping for house-service, as in suburban or high locations, where current for incandescent light is at hand, is effected by a small, automatically-controlled pump in the basement. The pumping for a whole city may be done by electric motors, as at DeKalb, Ill., Austin, Texas, and other places. Proposals have been called for by several cities for such pumping plants. Not long ago



TWO VIEWS OF WORTHINGTON 10 X 12 TRIPLEX PUMP WITH TWO GENERAL ELECTRIC INDUCTION MOTORS, INSTALLED BY CIA. DO BOA VISTA, BRAZIL.

Buffalo, New York, considered seriously the purchase of a thirty-million-gallon power-pump to be driven by power from the famous plant at Niagara Falls; though a steam pumping engine similar to another in place was finally purchased, the decision was made for other reasons than doubt of the economy and reliability of the proposed power-pump. The arguments for and against were extensively discussed in the local press. The only requisite in the case of water-works-pumping is reliable electric power at a cost as low as that of the same amount of steam-power, and sufficiently controlled by the corporation operating the pumps.

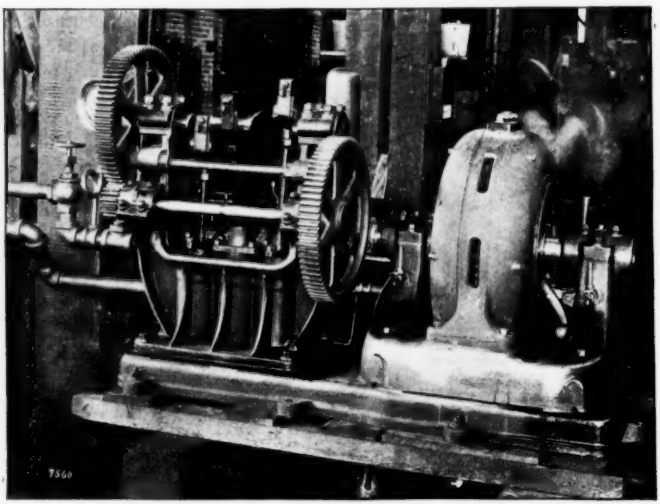


75-H.P. WESTINGHOUSE MOTOR DRIVING QUIMBY PUMP; UNITED SMELTING & REFINING CO., PRICKLY PEAR JUNCTION, MONT.

A search of periodicals and catalogues shows that the electric plunger and piston pumps built and advertised to date cover a wide range in size and service. Self-contained house-service pumps of a capacity as small as fifty gallons per hour are built by several well-known makers. They are often belted to the motor to avoid the noise of gearing. Larger pumps are duplex or triplex, vertical or horizontal, according to conditions of service, and are generally geared to the motor. The self-contained machine is convenient, but the purchaser must not think that he can set it "anyhow" on its foundations, and expect good results. The best machinery may be spoiled by careless treatment.

Vertical pumps are offered for low service by all makers, where conditions of space allow, as there is less friction loss. In the favorite type the connecting-rods are journaled on pins near the bottom of its single-acting trunk-plungers. Horizontal single-acting pumps are offered for heavier pressures, and double-acting for larger capacities. Several good track and sinking pumps are on the market, designed to suit their peculiar conditions. For low service the rotary types are often useful, and they are peculiarly adapted to driving by motors.

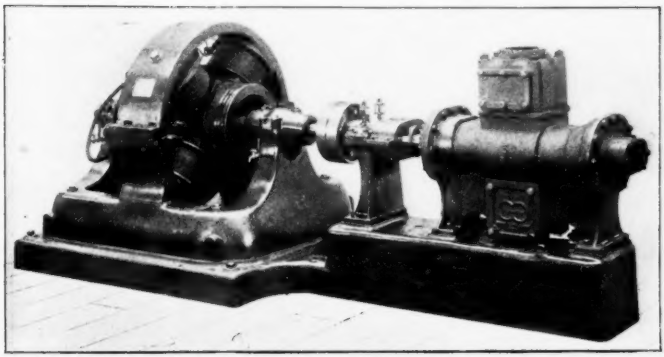
The rotary-gear pump has not yet appeared with motor drive. It might be found useful as a fire-engine, to take power from neighbor-



KNOWLES VERTICAL TRIPLEX PUMP WITH GENERAL ELECTRIC INDUCTION MOTOR. CIA. DO BOLIO, SANTA ROSALIA, L. C.

ing trolley wires, or for other special service. A curious form, consisting of two similar parallel square-thread screws meshing one with the other, and forcing the liquid contained in the spaces between the threads in a direction parellel to the axes of the screws, has been for some time on the market.

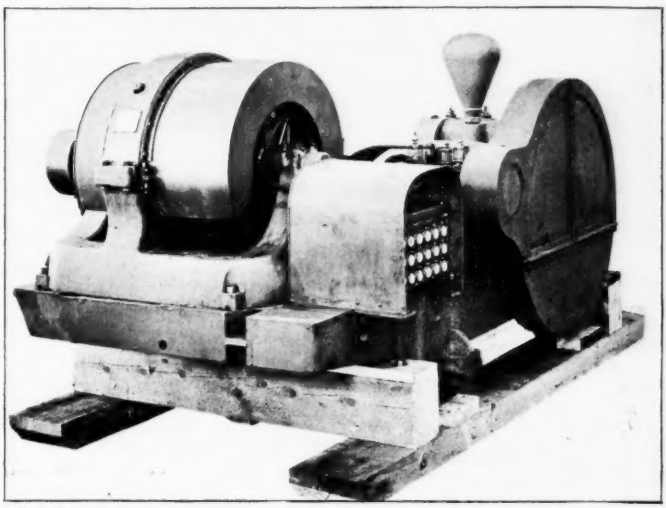
Large pumps for waterworks are of the regular designs. They are geared to motors instead of turbines; otherwise, the arrangement is the same. Vertical pumps are often demanded, to get within range of suction-lift from supply, but of these no definite class is yet developed. As with steam-pumps, each problem is worked out to suit its own conditions.



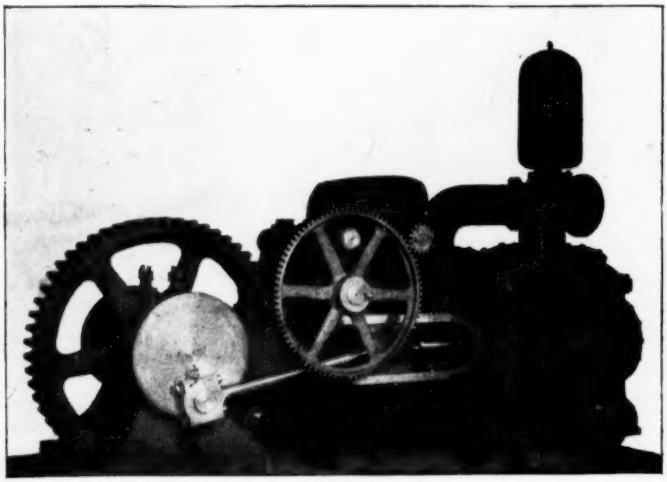
QUIMBY SCREW PUMP WITH 20-H.P. GENERAL ELECTRIC MOTOR.

The purchaser may obtain his electrically-driven pump through either the large electric companies or the prominent pump-manufacturers, or he may buy the two machines separately and combine them himself. It is probably best to allow one manufacturer to furnish the set, and thus get the benefit of careful adaptation of pump to motor.

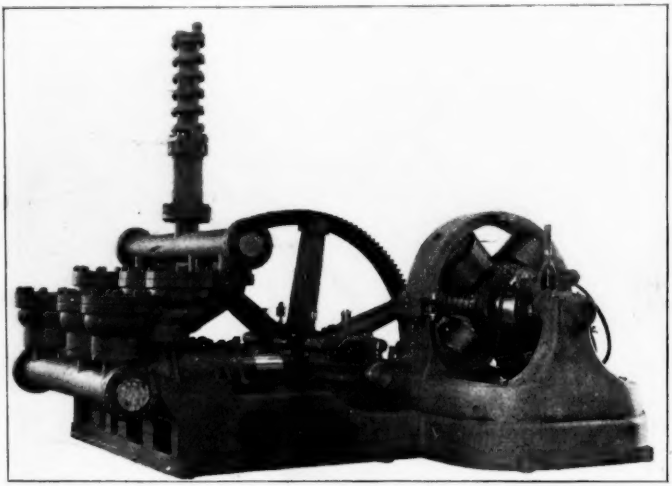
While the fundamental principles of design are the same in all



6½x8 HORIZONTAL TRIPLEX TRACK-PUMP, WITH 10-H.P. GENERAL ELECTRIC MOTOR; YOUGHIOGHENY RIVER COAL CO., SCOTT HAVEN, PA.



14x18 BARR PUMP, CAPACITY 1500 GALS. PER MINUTE, WITH EDISON MOTOR; SAULT ST. MARIE, MICH.

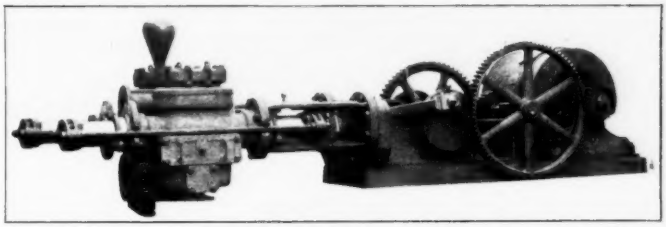


KNOWLES 6½x8 SINGLE-ACTING HORIZONTAL TRIPLEX PUMP WITH 50-H. P. SLOW-SPEED MOTOR; CATORCE, MEXICO.

pumps, the proper departures from established precedents necessary to meet new conditions are best decided by the application of the wide experience gained in the manufacture of the most successful pumps and electric machinery, rather than by a readiness to try every new idea.

The early motors ran very fast, requiring great reduction of speed by the transmission organ, whether belt or gears, to enable them to drive the usual line shaft or machinery. Designers have overcome this trouble, and offer low-speed motors, which may be connected by convenient, simple, and sightly means to the shafts to be driven, the increased floor space required for the motor being partly compensated by the compactness of the transmission, and part of the increased first cost by the saving in friction-loss and noise.

The type of pump is selected with reference to the service, as previously outlined. The machine must be carefully designed for strength; for, while the steam-pump is itself a very efficient alleviator



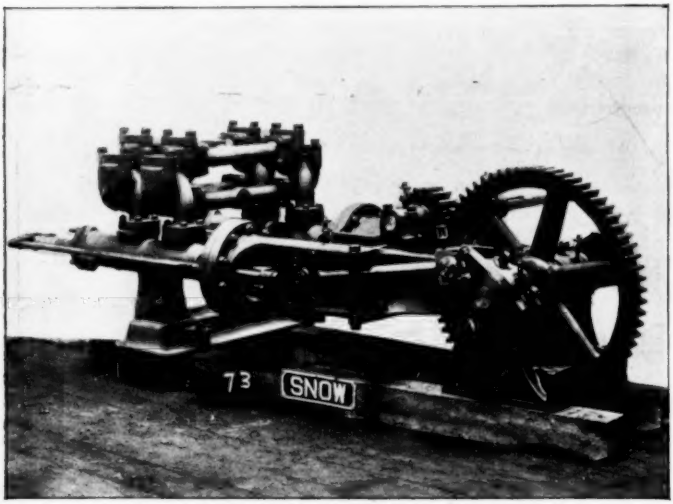
JEANESVILLE 5x8 DUPLEX PUMP WITH 7-H. P. SLOW-SPEED GENERAL ELECTRIC MOTOR; DERRY COAL CO., DERRY, PA.

of shocks or water-hammer, the crank-pump receives such shocks on its rigid metallic connections. All pocket-books and pump literature state that the waterways through the pump should be of ample area, that air pockets should be avoided in suction pipe and pump-chamber, and that efficient cushioning devices should be provided. A maximum speed of water through valves of not more than two hundred feet per minute, and valves of low lift, are also advised. But none of these are hard and fast rules, and they are often set aside; the purchaser must depend on the ability of the manufacturer for the success of his pump.

The simplicity of the triplex single-acting plunger pump, with its single set of valves for each plunger, is commendable. The objections to this pump are the three points of maximum resistance in each revolution of the crank-shaft, and consequent greater fluctation of turning effort, as compared with the six maxima per revolution of the double-acting type; also the generally larger parts of the single-acting pump,

for a given capacity. The differential plunger is single-acting as regards its suction and discharge valves, while double-acting as regards the effort on crank-pins due to discharge-pressure, and is thus a good compromise, in spite of slightly greater complication. Convenience of overhauling and means of getting at valves, and provision for taking up wear, are good points. A stiff, one-piece crank-shaft is desirable, and, unless very short, it should have bearings at each crank.

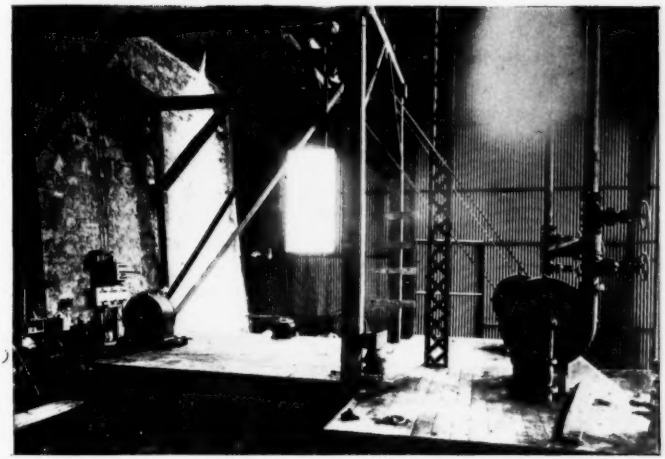
Belt-connection between pump and motor is used in small sizes. The usual and preferred practice is to employ gears,—a single reduction, if possible, cut teeth, fine pitch, wide face, and carefully set.



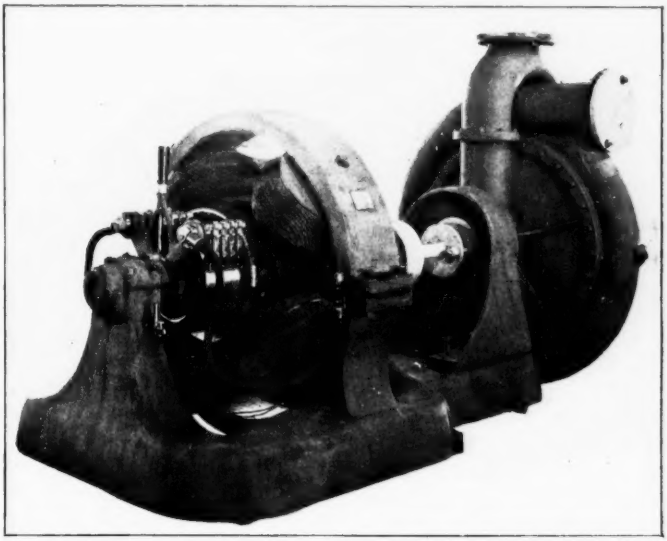
SNOW 2½ X 2½ DUPLEX PUMP FOR 1000–2000 LBS. PER SQ. IN. PRESSURE, ARRANGED FOR ELECTRIC DRIVING.

Rawhide pinions are furnished, where necessary, to reduce noise, and steel gearing where great strength is needed.

The centrifugal pump possesses one advantage over the reciprocating pump, when electrically driven, in that it may be directly coupled to the motor. These pumps do not compete to any great extent with the plunger type, for they find their field where the head is very low, as in draining land, emptying docks, circulating liquids, or raising sewage, or in dredging and wrecking operations, where the pump must lift and pass sand, stones, coal, and anything else that may happen to get in the way. They are cheapest of all in first cost, for the amount of water handled, but not always cheapest in opera-



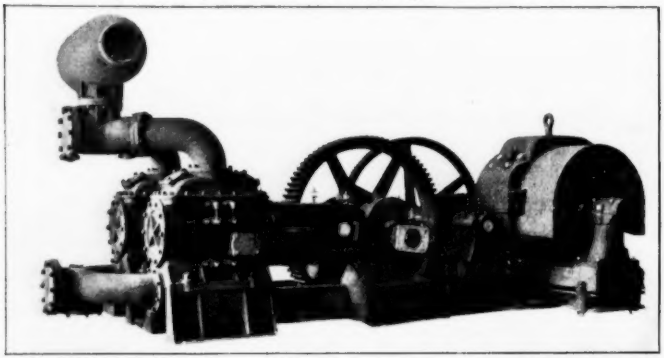
CENTRIFUGAL PUMP DRIVEN BY 20-H.P. WESTINGHOUSE MOTOR. DE LA MAR MINE, MERCUR, COLO.



LAWRENCE CENTRIFUGAL PUMP AND 4-POLE 60-H.P. 550-VOLT GENERAL ELECTRIC MOTOR; CATARACT CONSTRUCTION CO., NIAGARA FALLS, N. Y.

tion. Comparing the reciprocating pump with the centrifugal, it may be said that the former is an enlarged portion of a water-pipe, through which the liquid flows at a reduced and fluctuating speed, while the latter is a contracted portion of the pipe, through which the water flows at an increased, but uniform, speed. There are no shocks from water-hammer to guard against, and no valves of any kind except the foot-valve to hold the suction, used where the pump has to lift a considerable distance.

The usual electric motor has a horizontal shaft ; hence the vertical centrifugal pump is not as well adapted as the horizontal to this drive. Where the suction is taken at one side only, there is an end-thrust on the shaft, which must be resisted by some form of thrust-bearing. With the forked suction-pipe this is avoided, but it is impossible to get as easy curves in the piping, and the crotch offers a



9½ X 12 DEANE DUPLEX PUMP WITH 110-H.P. GENERAL ELECTRIC MOTOR; COLORADO FUEL & IRON CO., ROUSE, COLO. CAPACITY 1,000,000 GALS. IN 24 HOURS. WATER PRESSURE 150 LBS.

place to catch sticks or other *débris* in the water. Another way of balancing is to pass half the water through the central blade of the wheel, and, by having vanes on both sides of this, to do half the pumping against the back of the casing of the pump. This arrangement permits removal of the wheel through a cover on one side of the case. The capacity and head vary with the speed of the pump, so that the amount of water pumped cannot be measured by a revolution-counter.

There is thus one more field in which electricity will, to some extent, displace the small steam-motor. With the manufacturers of pumps and motors working in harmony, we may expect to see the rapid development of other electric devices to their present excellence repeated in the case of the electrically-driven power-pump.

THE TIMBER WEALTH OF PACIFIC NORTH AMERICA.

By Frank Haines Lamb.

THE enormously wide and rapid growth of the use of steel, as a material of construction, has tended to cast the shadow of subordination, if not the suspicion of discredit, upon the older material, wood. Its actual position, however, is not one of impending disuse, but of modified (and more intelligent) use. It would only parallel phenomena observed in other lines of engineering progress, if the new order, which at first seems to threaten the old, should eventually enlarge it, and wood, in a somewhat different range of applications, should be even more extensively employed through the larger works which steel has made possible.

The countries of Europe where little lumber is available have long drawn upon the forests of eastern British America and the United States. Now, the opening of the east, the extension of railways in China, the growth of mining in south Africa—all afford markets directly tributary to the Pacific coast of North America, from the Northwest Territory through British Columbia into Oregon, Washington, and California. The distances are great, and reckless methods of lumbering in the past have to be paid for by increased difficulties to the present mills; but improved methods of transportation, such as those recently described by Mr. Bishop in THE ENGINEERING MAGAZINE, combined with improved and more economical methods of felling, the application of mechanical means to reduction of labor costs, and more careful study and discrimination in the selection and utilization of different woods—these offer great opportunities which appeal most strongly to the lumber interests of extreme western Canada and the United States.

These regions are dependent, primarily, upon the distribution of the various species of lumber-producing trees, and, secondarily, upon the accessibility of these areas to the markets of the world. The timber trees of the Pacific coast belong, with but few exceptions, to the *Conifers*, or cone-bearing trees. In California and southern Oregon are forests of various species of oaks, and along all streams are different species of cottonwoods, alders, and maples, all of which yield a timber which could be utilized in many industries; but these remain almost entirely undeveloped.

Taking into account the principal timber-producing cone-bearing

trees, we immediately recognize as most important and most widely distributed the Douglas fir,* which masquerades under a great variety of common names. Lumber merchants are familiar with it as Oregon pine, when the lumber comes from Oregon. In Washington it is commonly known as fir, or Douglas fir. This species has an unbroken distribution from the British Northwest Territory to Lower California and from the seacoast to the Rocky mountains. It is extensively lumbered only in British Columbia, Washington, and Oregon. This tree, in size, is second only to the California redwood. The trees now cut for market range in size from 26 inches to 100 inches in diameter, the average being from 60 inches to 72 inches. In the forests this tree reaches a height of from 150 feet to 300 feet, and under the best of conditions logs have been obtained 125 feet in length with a diameter of 36 inches at the smaller end. From this tree bridge timbers 110 feet by 8 inches by 16 inches have been obtained, perfectly free from knots, pitch rings, or imperfections of any kind.

Owing to our imperfect knowledge of the properties of American woods, all statements are liable to modification in the light of further investigation. Tests made by the division of forestry, United States department of agriculture, on various species of cone bearing trees established the superiority of Douglas fir to all others. In the transverse strain, test sticks 1.5748 inches square, resting on supports exactly 39.37 inches apart, were used. Under a strain of 1,213.53 pounds this species gave a deflection of 1.753 inches and an ultimate strength of 1,238.98 pounds, while northern white pine, under 661.38 pounds' pressure, gave a deflection of 2.4427 inches and an ultimate breaking strength of only 756.17 pounds. In order to produce an indentation of 1.851 inches it required, on Douglas fir, 45,304.5 pounds' pressure; to produce the same effect on northern white pine it required but 13,900 pounds.

The Northern Pacific Railway Company tests for bridge purposes showed that a stick 4 feet by 2 inches by 4 inches, laid on supports 3 feet 9 inches apart, required for its fracture a center load of 4,320 pounds, while eastern white pine required only 1,610 pounds and a stick of green eastern oak but 2,430 pounds. Various other tests have been made, all proving that the transverse breaking strength of Douglas fir is equal, if not superior, to that of the best eastern oak. Government tests give the specific gravity of air-dried specimens as 0.5157; ash, 0.08; and weight per cubic foot, 32.14 pounds.

Next to Douglas fir, the California redwood † is best known and most extensively manufactured. It grows in a belt parallel to the coast and not exceeding fifty miles in width, from the northern bound-

* *Pseudotsuga taxifolia.* † *Sequoia sempervirens.*

ary of California to near Monterey, south of the bay of San Francisco, —in all, a length of about 300 miles. It forms nearly pure forests on the moist, fog-laden coast ranges. The redwood is a very soft timber of coarse grain and a brick red color, which is very bright when freshly cut, but soon becomes dull when exposed. It does not warp or shrink, and does not readily ignite.

According to tests made at the University of California,* a green beam 200 inches long, 3.84 inches thick, and 5.60 inches high broke under a center dead-weight of 19,610 pounds. A seasoned stick 200 inches long, 4.02 inches thick, and 16.15 inches high, broke at 25,440 pounds. For all construction purposes where strength is not required, and for shingle and interior finishings, it is excellent.

North of the California-Oregon line there are two timbers of more recent introduction, both of which are being well received in the markets of eastern America. Extending in a narrow belt, in no place over twenty miles in width, along the coast from south-eastern Alaska to Coos Bay, Oregon, is the tideland spruce.† On the western coast of Washington, where it reaches its perfection, it forms from 25 to 75 per cent. of the forest cover. In size it equals Douglas fir. The trees growing in the dense woods are remarkably straight and clear, while those growing in open places are covered with limbs to the ground, and are of no commercial value. The wood is nearly pure white, without pitch, odor, or taint ; it is very tough, and, when worked with sharp knives, it takes a good finish.

Its transverse breaking strength is almost equal to that of the white pine of the eastern United States ; its deflection is only about half as great. Its specific gravity is less than that of any other cone-bearing tree yet tested,—0.3449. The weight per cubic foot is only 21.49 pounds. Since it can be artificially dried, it is peculiarly adapted to long shipments on account of the low freight weight.

With a somewhat similar north and south extension, but extending from the coast to the Cascades, is found the Pacific coast red cedar.‡ Like the tideland spruce, it rarely forms a forest growth by itself, but is nearly always present, forming from 10 to 50 per cent. of all forests. Its headquarters is about Puget sound and along the coast of Washington. This wood also has a low specific gravity (0.3796), and weighs 23.66 pounds per square foot. In color it much resembles the redwood ; it has a strong odor and taste ; its grain usually is coarse. In transverse strain tests it equals white pine, and is superior to it in compression tests.

Scattered throughout the dry interior valleys and on the higher

* Pacific Coast Wood and Iron. Vo. XXVII. No 5.
† *Picea sitchensis.* ‡ *Thuja plicata.*

foothills of California and southern Oregon are limited quantities of the sugar pine.* This is an excellent white lumber of great strength, taking a good finish. Extending over a very limited area at Coos bay is the Port Orford cedar,† while crowning the mountain summits of Washington, British Columbia, and reaching down to the coast in Alaska, is its sister, the Alaska cedar,‡ or Sitka spruce. These two trees, so little known in the market on account of their scarcity and inaccessibility, are the most valuable of all the Pacific coast trees. They are probably the strongest and toughest of all the conifers, and take the finest finish.

Along the western flank of the Sierras, extending from California, are scattered the score or more groves of the Big Tree.§ The total area of these groves originally did not exceed 35,000 acres. Many are as yet untouched, but in the more accessible the saw-mill is eating them away. The lumber almost identically resembles the redwood,—the apparent differences being that it is perhaps a shade redder in color, and of coarser grain.

On the dry interior valleys and foothills of California and east of the Cascades, on the plains and hills of eastern Oregon, Washington, and Idaho, are many large tracts of the yellow pine.|| Much of this is lumbered to supply local demand and for mining purposes. It is in every way an inferior lumber, and will not take any large part in the future of the lumber trade. In the southwest, on the mountains of Oregon, in the celebrated Coconino forest, grows the Arizona yellow pine. This is destined for a similar fate,—that of supplying local demands for ordinary lumber.

The western hemlock¶ has a general distribution west of the Cascades, extending from southern Oregon into British Columbia. This tree does not reach the immense size of its companions in the woods, but further tests will reveal its superiority for many construction purposes, the timber being far superior to the hemlock of eastern America. In addition, it possesses a very beautiful grain, and readily takes a beautiful finish. Owing to its great weight, green logs do not readily float. As long as logging operations depend upon water, it will not be cut. At present the wholesale waste and destruction of this timber, incidental to the cutting of the fir, cedar, and spruce, is the greatest crime which can be laid at the doors of the lumberman of the Pacific northwest.

This completes the list of those trees that have found their way into commerce. In the future many other species will, in limited quantities, be lumbered.

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* *Pinus lambertiana.* † *Chamæcyparis lawsoniana.* ‡ *Chamæcyparis nutkatensis.*
§ *Sequoia gigantea.* || *Pinus ponderosa* and varieties. ¶ *Tsuga mertensiana.*

Along tidewater, from British Columbia southward about Puget sound, the Columbia river, and thence south to San Francisco, or wherever a railroad line has penetrated into these belts of virgin timber, saw-mills have arisen.

Beginning on the north, the international line separates the mills of British Columbia from those of Puget sound. Fir is the chief lumber produced, cedar being second. The latter, however, is almost exclusively confined to the production of the red cedar shingles. The chief mills are located at Chemanus, Vancouver, Moodyville, New Westminster, and Victoria. It is estimated that there are five hundred thousand acres of timbered land in the province. Of this one-fourth is owned by one company. The mills and the methods of manufacturing resemble almost exactly those of Washington. At present the logs cut do not supply the mills of the province, and last year logs were towed two hundred miles from Puget sound.

First in importance of all the lumbering regions of the Pacific coast is Puget sound. This great inland water-way, with its multitude of excellent harbors and its intricate network of deep-water bays and inlets, affords ideal situations for manufacturing establishments of all kinds. Bordering the water on all sides are almost continuous forests of virgin timber. On the gravel plains close to the sound the timber is mainly Douglas fir, of medium size and quality, as a result of frequent burnings; but on the slopes of the Cascades and Olympics, facing the sound country, are vast forests never touched by fire.

Hardly a town of the sound region that is accessible is without a saw-mill of some sort. There are about three hundred mills of all descriptions, making lumber or lumber products. The largest mills are located at Tacoma, Port Blakely, Port Gamble, and about Bellingham bay. Following are some statistics regarding the largest mills:

Name of Plant.	Daily Capacity 10 hrs.	Lumber Manufacturing, 1897	No. Employed.	Location.
Port Blakely Mill Co.	300 M.	97,000,000	800	Port Blakely.
Puget Lumber Co....	225 M.			Port Gamble.
	175 M.			Port Ludlow.
St. Paul & Tacoma Lumber Co.....	175 M.	58,424,126	600	Tacoma.
Stimson Mill Co	150 M.	41,320,322	200	Ballard.
Tacoma Mill Co.....	250 M.	57,810,000	250	Tacoma.

Nearly the entire lumber production of the Puget sound mills consists of Douglas fir. Spruce is not obtainable, hemlock is allowed to waste in the woods, and nearly all the cedar is consumed in the manufacture of the well-known Washington red-cedar shingles.

The shingle mills of Puget sound are almost as numerous as the lumber mills; indeed, most of the large lumber plants have a shingle department. One plant at Tacoma has a capacity of 600 M. daily, and more than fifty have a daily capacity exceeding 100 M. pieces.

Extending along the coast from Gray's harbor, Washington, south to Coos bay, Oregon, is the coast lumber region. This is the only region able to manufacture the tideland spruce. Owing to the lack of rail communication, the spruce woods of Oregon are, as yet, little developed, but in Washington both Gray's and Willapa harbors have direct communication by rail with eastern markets. As a consequence, numerous mills have sprung up about these harbors, at first shipping only by water, but within the last decade finding a ready and more profitable market in the eastern States. The larger part of the lumber produced still consists of fir: the immense bodies of cedar just back from the coast are almost untouched as yet. Shingle mills have arisen like mushrooms, and already the supply of cedar is hardly equal to the demand. As a rule, these mills are of smaller capacity than that of the mills of Puget sound. On Gray's harbor there are half a dozen with a capacity of 100 M. daily, while south, along the Oregon coast, most of the mills cut from 50 M. to 75 M. daily. These are situated on Coos bay and the Coquille and Umpqua rivers, but, being without rail connections, the entire product goes coastwise to California ports. All of the coast counties of Oregon are heavily timbered, needing only development.

Portland boasts of being the king lumber city of the coast. In 1897 its ten mills cut 135,000,000 feet B. M., but its capacity is easily 200,000,000 feet B. M. yearly. The lumber manufactured is principally Douglas fir, which is known here as Oregon pine, with a little spruce box material. Logs are obtained from the Columbia and its tributaries, mainly below Portland. Contiguous to Portland are the shingle mills of the Cowlitz river, Washington. Portland's largest two plants have each a capacity of 50,000,000 feet B. M. annually.

South of the Oregon line, along the coast of California, is the redwood belt. The principal mills are situated in Humboldt, Mendocino, and Del Norte counties. From the mills the lumber is transported to the coast and then loaded into coastwise schooners for San Francisco. Owing to the lack of suitable harbors, loading is often accompanied with great trouble and danger. The schooner approaches as near as possible to a rocky cliff. A cable is shot across her bow, and down this are sent the cars of lumber. Often a storm arises, which necessitates withdrawing into the open sea, and often a schooner will lie to for days, waiting for an opportunity to load.

Lying east of the coast ranges, from southern Oregon into northern California, about the slopes of the Siskyou mountains, is a large body of yellow and sugar pine. Since the completion of the California & Oregon railroad many mills have sprung up in this section. In many cases the logs are brought from a distance and at considerable expense. The lumber manufactured goes to San Francisco.

Scattered throughout central California, along the western slope of the Sierras, are numerous mills, some like those about Truckee, supplying the demands of the large mines, others shipping into San Francisco. The lumber manufactured consists mainly of yellow pine, with some sugar and bull pines and California post cedar. Back of Fresno and Visalia, in the Sierras, are several mills that are rapidly eating away the Big Tree groves. These mills manufacture their lumber about forty miles from the railroad, to which the product is afterwards floated down a flume.

The estimated cut of all Californian mills outside of the redwood district may be given as 235,000,000 feet B. M., divided as follows:*

Yellow Pine	100,000,000
Sugar Pine	75,000,000
Douglas Fir or Spruce	50,000,000
White Fir	10,000,000

Eighty per cent. of the common product of yellow and sugar pine is used for the manufacture of boxes.

Separated as the Pacific forests are from the markets of the eastern States by two or three thousand miles of country, the coast lumber was for a long time dependent upon local consumption. From 1850 to 1870 the redwood mills of California and the fir mills of Oregon and Puget sound had to rely entirely upon the San Francisco market. That city in turn acted as a distributing point, supplying the interior cities of California.

In 1869 the first cargo of lumber was shipped from Coos bay to Hawaii, and since that time the foreign cargo business has steadily grown, until at the present time it has reached mammoth proportions, reaching almost every country and making the Pacific coast timber familiar in almost every port.

Douglas fir constitutes the principal timber sent abroad. All dimensions and qualities find a ready market, while China and Japan are now demanding large timbers for their various engineering works, now under construction. Of the total cargo shipments 163,537,944 feet B. M. was cut in Washington. The mills of British Columbia supplied sixty-five cargoes, aggregating, in round numbers, 68,000,000 feet B. M., and the redwood mills of northern California shipped

* Pacific Coast Wood & Iron.

more than 20,000,000 feet of redwood. During 1897 three hundred and eleven cargoes were shipped from the mills of the various portions of the Pacific coast. The total shipments amounted to 275,707,060 feet B. M. Their destination is shown by the following table:

CARGO SHIPMENTS FROM PACIFIC COAST.

	1897.
	655,656 ft. B. M.
Society Islands	1,065,565
Calcutta, India	15,975,676
South Africa	35,219,079
Europe	34,055,753
Central and South America	13,994,033
Mexico	4,238,274
Siberia	5,722,468
Hawaiian Islands	25,234,253
Honolulu	17,694,635
Japan	26,077,586
China	76,152,560
Australian Ports	
Total	257,707,060

The indications for the coming year point to a lowering in the foreign freight rates, due to the light grain crop of California. At present the average charter prices for the principal foreign lumber export ports are as follows:

		Shillings per 100 ft. B. M.
Pacific Coast Ports.	To South Africa	65–70
	United Kingdom	60–65
	South America	35–40
	Japan } China }	42–45
	Australia	45–55
		U. S. currency per 1 M.
	Central America	$8.00
	Mexico	8.00
	Honolulu	7.00

The shipment of lumber by rail was made possible in 1888 by the completion of the Northern Pacific Railroad into Tacoma, thereby making direct rail communication between the mills of Puget sound and the markets of the eastern States. In 1890 systematic shipping by rail began. From that time it has constantly increaseed. Statistics for California and Oregon are not available, but a comparison of the rail shipments from Washington for the past four years will be of interest.

COMPARISON OF WASHINGTON RAIL SHIPMENTS.—IN CARLOADS.

	1894.	1895.	1896.	1897.
Lumber	4,282	5,662	6,611	7,671
Shingles	10,992	13,776	14,118	17,540

In thousand feet B. M. the shipments of fir, 1896 and 1897, are:

1896.....103,836,000.
1897.....122,736,000.

The entire production of red cedar shingles is confined to Washington and British Columbia. From Washington there were shipped in 1897, by rail, 2,854,400,000 shingles; besides, 6,500,000 were shipped by sea.

With the extension of the Northern Pacific to Gray's harbor in 1892 the first shipment of tideland spruce was made to the eastern States. This timber is largely used for interior finishing and car-construction, and is becoming very popular in the market.

The following brief table of freight rates to principal points in the eastern States is compiled from the present schedules:

	Fir.	Spruce or Shingles per 100 lbs.
Puget Sound to Omaha	50	60
St. Paul	40	50
Chicago	50	60
Buffalo	65	75
New York	73	83
Boston	75	85
Philadelphia	73	83
Cleveland	62	72

No careful estimate of the actual cut of the Pacific coast mills can be given, since in many sections no reports are made. Following is an estimate based upon the best authority:

LUMBER PRODUCTION OF THE PACIFIC COAST FOR 1897.

			AUTHORITY.
British Columbia.	Foreign	68,000,000	W. C. & P. S. Lumberman.
	Rail	25,000,000	Estimate.
Washington,	Coastwise	243,522,979	W. C. & P. S. Lumberman.
	Foreign	163,537,944	" "
	Rail	122,736,000	" "
Oregon,	Portland	130,000,000	Portland Oregonian.
	Except Portland	420,000,000	" "
California	Redwood	213,249,456	Pacific Coast Wood and Iron.
	Interior Mills	235,000,000	" " " (Estimate).
	Rail	113,275,000	" " " "
	Total	1,724,321,379	Feet B. M.

Washington Shingle Output .....2,860,900,000 pieces.

The coastwise cargo trade to domestic ports still continues to demand a large proportion of the entire Pacific coast cut. Most of this goes to San Francisco, and a smaller portion to southern California.

The problem of transportation is undoubtedly the most vexatious with which the Pacific coast lumberman has to deal. A decrease in the cost of transportation opens new markets, and increases profit in old markets.

The past decade has been marked by a constant evolution in the methods of harvesting and manufacturing lumber. Where the ox-team laboriously drew to tidewater a turn of logs a few years ago, the steam donkey now performs the same task cheaper and more conveniently. As the timber was cut away from tidewater, cattle became useless, and to-day the wire cable penetrates into the woods for a distance of six thousand feet from the camps, hauling the great firs over stumps and up steep grades as easily as the ox team could haul them on a down grade, and more expeditiously. As the camps have penetrated further into the woods, railroads have followed in their wake. There are now operating in Washington logging railroads hauling thirty-three miles to tidewater, while the trans-continental lines have added to their business by hauling logs from the western slopes of the Cascades to the mills of Puget sound.

The occurrence of fires among the mills has kept the majority of them up to date. Where immense logs have to be handled, the best and most complete appliances must be used. The circular saw is gradually giving way to the lumber-saving band saw. With the revival of the lumber trade every mill is increasing its capacity. This is accomplished by the addition of improved machinery. Dry kilns and planing mills are being added to nearly every plant, so that the market of the eastern States can be entered.

The Pacific coast forests are not "inexhaustible,"—far from it,—but, with proper use and care, they should be equal to the future needs of home and foreign consumption. The forests now standing are mature, and are not bettered by not being cut. At least 90 per cent. of the cut-over lands are of absolutely no value for agricultural purposes. They are adapted only to timber growing. Moreover, the native species, if protected from fire, are, as a rule, readily and quickly reproduced. Let land-owners and loggers recognize these facts, and treat their cut over lands as growers of another timber crop. Let a wise policy protect the forests and cut-over lands from fire, and further the work of reforestation. The lumber industry is legitimate and necessary business, despite certain sentimentalists; moreover, if properly managed, its future has more in store for the Pacific coast than all that her gold fields have yielded.

THE MINING, SMELTING, AND REFINING OF NICKEL.

By Titus Ulke.

AT the Canadian Copper Company's refinery at Sudbury the matte, after remelting in cupolas, is sometimes run into bessemer converters, similar to those used in the refining of copper. There are three converters in the refinery, one being in use, while a second is being relined and a third is kept in readiness for a charge, when the bessemer plant is in operation. The capacity of the latter is about twenty-five tons of cupola matte supplied, or fifteen tons of bessemer matte produced in twenty-four hours. In the converters the iron is almost entirely removed, the sulphur is lowered to about 14 per cent., and the copper and nickel are raised to about 43 per cent. and 40 per cent. respectively. As there are none of the usual flame reactions to guide the operation, the point at which to stop the blowing, after the iron has been removed and before the nickel has commenced to slag in undue amounts, is a matter in which the skill of the furnace manager is best shown. As the converter slags rarely show more than 2 per cent. of copper and 3.5 per cent. of nickel, and as the ratio of copper to nickel in the supply is nearly the same as in the product, sufficient proof is given of the skill and judgment needed and practiced in the bessemer concentration of a metal so easily oxidizable as nickel. All converter slags are returned to cupolas for remelting.

For convenience in handling, the converter matte is cast in slabs three feet square and about three inches thick, weighing about fifteen hundred pounds each. These slabs are lifted to the cars by hydraulic cranes, which serve for handling the converters. An average analysis of Canadian bessemer matte is: copper, 43.36 per cent.; nickel, 39.96 per cent.; iron, 0.60 per cent.; sulphur, 13.76 per cent.; silver, 7 ounces per ton; gold, 0.1 to 0.2 ounce per ton; platinum, 0.3 ounce per ton; palladium, 0.2 ounce per ton. This matte is produced only in very limited quantities, compared with ordinary matte, as the latter is in much greater demand.

In Europe much of the low-grade nickel matte is refined by bessemerizing, as the latter operation requires much less time than the reverberatory, or English, method of refining, to be described later.

At Havre molten Caledonian matte is run into one-ton converters, and is blown with a pressure of about forty centimetres of mercury.

The temperature rises, and a quartzose mixture is thrown on the surface to scorify the iron. If the matte does not contain more than 36 per cent. of iron, the latter can be removed in about one hour and twenty minutes. If there is more than this, the bath should be skimmed at least once after the first twenty-five minutes, and another portion of the flux added.

After the final skimming, and when the nickel is found to be oxidizing in its turn, the refined matte, containing but 0.5 per cent. of iron, 75 per cent. of nickel (including a little cobalt), and 24 per per cent. of sulphur, is run off. Nearly all of the arsenic, antimony, and silver are carried off by the blast, or enter into the slag. This slag contains 14 per cent. or 15 per cent. of nickel, mostly in the form of prills carried into the pasty mass by the blast. Part of this can be recovered by running the slag into settling-pots and allowing the metal to sink to the bottom. The slag, however, is generally returned to the blast furnace for remelting.

It seems natural to continue the action of the blast in the converter upon the matte freed from iron, in order to burn out the sulphur, and so obtain refined nickel, which would then need only to be heated in a reducing atmosphere to reduce whatever oxide may have formed, as is done with copper. Numerous attempts in this direction have been made, but it appears impossible to succeed with nickel in this way. After the iron has been removed, not only does the nickel oxidize with the sulphur, but the temperature falls, because the combustion of the sulphur, which is lessened by the latter's affinity for nickel, does not compensate for the cooling due to the injection of the air. The bath, therefore, tends to solidify, and this effect is the more speedy as the uncombined nickel produced can remain in the liquid state only at a very high temperature—near that of molten iron.

Bessemer matte, containing 800 pounds of nickel and 800 pounds of copper to the ton, was recently quoted at $125 to $180 per ton at Sudbury, the price largely depending on the quantity purchased.

The cost of bessemerizing the ordinary matte is said to be only $12 to $15 per ton.

6. The Orford Process, or Separation-Smelting. The prime object of this operation is the separation of the copper from the nickel in the Canadian matte. For this purpose the ordinary matte is subjected to preliminary treatment by calcining and then melting in a blast furnace, so that the metals are finally present substantially as subsulphides. With bessemer matte this preliminary treatment is, of course, unnecessary.

At the Orford works, which handle by far the greater part of the Canadian output, the matte is now charged with the proper proportion

of salt cake and coke into a water-jacketed Herreshoff furnace, whose contents, after melting, are passed into settling pots. In the furnace the salt cake, or sodium sulphate, is reduced to sodium sulphide, which unites with part of the iron and copper to make a very fluid mass, from which the sub-sulphide of nickel separates by gravity. On cooling, therefore, the bulk of the nickel settles to the bottom of the pot, and is separated by hand from the "tops," which contain the bulk of the copper, iron, and soda. The tops are exposed to the weather, whereby the sulphide is converted into sodium sulphate and carbonate, or into so called caustic soda. Then these tops are mixed with a little matte and sufficient coke, and remelted in a second blast furnace, whereby the "caustic" soda is converted into sulphide of soda at the expense of the nickel, leaving the latter in a semi metallic state, so that again a top and a bottom are formed, with copper and iron in the top and nickel in the bottom. By a similar treatment of the "bottoms" a relatively pure sulphide of nickel is finally obtained. As the latter still contains copper, besides more than half of the platinum and palladium in the original matte, it is roasted with salt in a reverberatory furnace and heated to a temperature which will enable as much nickel oxide as possible to form, together with chloride and sulphate of copper, silver, and palladium. The roasted mass is then leached, to separate the more insoluble nickel oxide from the chloride and sulphate solution. Finally, the leached nickel oxide is sold as such, or is reduced, by smelting with coke, to crude nickel, which is cast into anodes for electrolytic refining.

7. Reverberatory-Refining (English Method). In France and Germany low-grade nickel matte is often refined in reverberatory furnaces.

The reverberatory refining, according to D. Levat, requires two operations, each of which includes two phases,—*viz.*, roasting, and fusion with quartzose sand, in order to scorify the iron. Two tons are treated per furnace in twenty-four hours, with a consumption of two tons of coal. Samples are taken in the course of each operation (which lasts about eight hours), in order to arrest the work as soon as the iron has disappeared, thus preventing the passage of the nickel into the slag. The latter is seldom discarded before retreatment, for it often contains fully two to two and one-half per cent. of nickel, and makes an excellent flux.

The first operation in the reverbertory produces a matte with 2.5 to 3 per cent. of iron, the second a matte containing not more than 0.5 to 0.75 per cent of iron. The refined matte should not contain less than 16 per cent. of sulphur, so that it may be easily pulverized for subsequent treatment. The composition of the matte freed from

iron is generally as follows: nickel or cobalt, 75 per cent.; sulphur, 24 per cent.; iron, 0.5 per cent.; other impurities, 0.5 per cent. The total impurities should not exceed one per cent., for the subsequent operations remove only the sulphur. For this purpose the matte is crushed to 65 mesh, and is roasted in a large furnace (33 feet long by 8 feet wide), with four doors on a side, to enable the workmen to rabble the charge along toward the fire-bridge. The charge is about 1,400 pounds, and the operation lasts six to eight hours. In twenty-four hours about one and one-half tons are roasted and one ton of coal is consumed. The temperature is kept at a dark-red heat, to prevent fusion and produce an oxide with only a small proportion (about 1 per cent.) of sulphur and sulphates. This material, after being crushed to 120 mesh, is then subjected to another roasting, during which the temperature is raised to a bright red. The resulting oxide (or oxides, for copper oxide from a cupriferous matte is not eliminated) should not now contain more than 0.4 per cent. of sulphur. It is reduced in either loose condition, or after having been formed into cubes, with charcoal in crucibles, or subjected to a direct reduction-melting, the metal being refined with a little magnesium, and cast into cakes, or shotted.

It is estimated that the total cost of reverberatory refining and the production of metallic nickel from one ton of matte slightly exceeds $20.

8. The Wet Process of Refining. The wet process of refining is used in Europe on ores, speiss, matte, and richer nickel products containing copper, when absolutely pure nickel is desired.

The above raw material is pulverized and calcined, if necessary, and is then leached with hydrochloric acid, aided by steam. A chloride solution of the soluble metals is thus obtained, which is siphoned off from the waste gangue and ferric oxide. To remove the balance of the iron and the arsenic, the solution is treated with both chloride and milk of lime, together with steam, whereby any arsenic and ferrous iron present are peroxidized and precipitated. The copper contained in the solution drawn off from the ferric hydrate and iron arsenate precipitate is now thrown down in the acidified heated solution, by means of sulphuretted hydrogen, and the resulting copper-sulphide, available for the production of copper, is filtered off. Should the filtrate, a solution of nickel chloride, contain cobalt, the excess of the hydrogen sulphide must be boiled off, the excess of acid neutralized with milk of lime, and the cobalt peroxidized and precipitated with steam and chloride of lime. The products thus obtained are cobalt oxide which goes into the market, and a solution of nickel chloride.

For the production of metallic nickel from the chloride solution nickel hydrate is precipitated by means of milk of lime. The dried hydrate is then made into a paste with flour, and baked. The baked mass, broken into fragments and strongly heated, parts with its carbon and gases, and leaves metallic "grain nickel," which is sold.

9. Electrolytic Refining. Orford anodes, containing 95 to 96 per cent. of nickel, 0.2 to 0.8 per cent. of copper, 0.75 per cent. of iron, 0.25 per cent. of silicon, 0.45 per cent. of carbon, 3 per cent. of sulphur, and 0.5 ounce of platinum per ton, are electrolytically refined at the Balbach Works, Newark, New Jersey, for the Orford Copper Company.

There is reason to believe that a neutral or slightly ammoniacal sulphate bath is employed in this process. According to Dr. Foerster the electrolyte probably contains about 480 grams of commercial nickel sulphate—*i. e.*, 100 grams of nickel—per liter, and is heated to a temperature of 50° to 90°C. Good, coherent deposits, bright grey or tin white in color, may then be obtained by using a current density of from five to twenty-five amperes per square foot of cathode surface. Other metallurgists, whose view the writer shares, do not believe that hot solutions are employed. In any case refined nickel is actually produced, containing from 99 to 99.6 per cent. of nickel, 0.12 to 0.14 per cent. of cobalt, 0.1 to 0.2 per cent. of copper, 0.1 to 0.4 per cent. of iron, 0.03 per cent. of arsenic, 0.02 per cent. each of manganese, sulphur, and silicon, and traces of platinum. The anode scrap and slime are partly treated to recover platinum, and are partly remelted into nickel anodes.

In the electrolytic refining of the crude nickel, certain precautions must be taken. It is, of course, necessary to guard against the accumulation of copper, arsenic, and iron in the bath; otherwise, serious injury to the deposited nickel may result. In a neutral sulphate bath, however, it is easy to eliminate the copper, if this metal is present only in small quantities, as the nickel of the anode precipitates it to a large extent immediately. Iron is the greatest obstacle, as it is apt to deposit with the nickel; anodes rich in iron should, therefore, be avoided, if nickel free from iron be desired.

In electrolytic nickel-refining a large quantity of anode scrap is invariably produced. This is unfortunately the case even with anodes averaging as high as 90 per cent. of nickel, owing to their uneven solution and consequent disintegration.

The usual difficulty in depositing a thick plate of pure nickel, due to its tendency to peel off, is overcome, it seems, when a heated neutral nickel-sulphate solution is employed. Under proper conditions, however, thick deposits may easily be obtained even with cold solutions.

At any rate, the Balbachs have succeeded in electro-depositing nickel plates 20 by 30 inches in size and ⅜ to ½ of an inch thick, which are so tough and elastic that it is very difficult to chisel the metal; and the shearing of plates more than 1 mm. in thickness is as troublesome as the manipulation of so much tempered steel. For this reason, and because of the difficulty of handling heavy cathodes, the Balbach Co., in refining for the Canadian Copper Co., take out the cathodes when they are about ½ of an inch thick. It is an important fact, also, that these plates, ordinarily, will neither break under the hammer or crack under the punch. Nearly three tons of this metallic nickel are now produced daily in Newark by the Balbach Smelting and Refining Company, and a small quantity by the German firm of G. Menne at Siegen. The greater portion of the output of pure nickel is used in making nickel steel and German silver, the balance being cast into anodes for nickel-platers.

The value of the platinum and palladium contained in the Canadian ore annually mined is more than $30,000. A part of this the electrolytic process saves, and it will soon be placed on the market.

The value of the world's product of metallic nickel and nickel oxide in 1897 exceeded, it is said, $1,300,000.

A MONTH OF ENGINEERING PROGRESS

A GENERAL view of engineering progress as indicated in the references in THE ENGINEERING INDEX this month shows several noteworthy features, some of which, as might be supposed, bear a close relation to recent political developments. The relation of the engineer to the statesman and to the development of such enterprises as the Siberian railway, the Nicaragua canal, and the Pacific cable frequently forces the hand of the politician and compels him to admit that the pen which is mightier than the sword may sometimes be the drawing pen of the engineer.

Not only is Nicaragua being discussed, but Panama is showing symptoms of revival, and although popular opinion is undoubtedly strongly in favor of piercing the isthmus at some point, the contest between the rival routes is by no means yet settled.

The acquisition of the Hawaiian islands by the United States has awakened the subject of a Pacific cable, which, if not all British, may at least be all Anglo-Saxon, and provide a solution of the political and commercial problem of communication between all parts of the British empire, freed from the possibility of interruption in case of a general European war.

As the work of the engineer often precedes political changes, so political and military upheavals create new demands upon the engineer. Papers upon battleship design, armor, and gunnery are the natural product of the experiences of the Spanish-American war, while the questions brought up by the experience on both sides with torpedo boats and destroyers have led to a re-opening of the entire subject of the construction and proper use of these highly-specialized fighting machines.

The political agitation and possible changes in the policy of the Chinese Empire have created much interest in the commercial world, and the engineering opportunities which would inevitably follow the opening or disintegration of China, are already being considered from various standpoints.

While England has been aroused to the fact that the admirable methods of technical instruction in Germany have had much to do with the rapid development of competition in engineering matters, the Germans are discussing the overcrowded condition of their technical schools, and endeavoring to transfer the ground-work of scientific education to the lower schools and, by stringent examinations and other restrictions, keep down the attendance of students in the higher schools to a more manageable number.

The interest in the Paris exposition of 1900 increases as the work progresses, and the plans for power generation and distribution, as well as the lighting of the Champ de Mars which are now made public, show the influence which the development of the modern power-house has had upon the engineers of the Exposition. Instead of a miscellaneous collection of engines and boilers arranged with entire disregard of each other, the visitors will see two well ordered power-houses, containing standard steam and electrical units, representing the latest practice of all industrial countries. The great arch of the Alexander III bridge will now also make rapid progress, since the false works across the Seine are ready for the reception of the superstructure.

The utilization of natural sources of power goes actively forward on both sides of the Atlantic, and accounts come from Switzerland and Sweden, from New York and Colorado, of the installation of hydraulic and electric power generating stations, while attention has been forcibly called to the vast amount of hydraulic power awaiting development in Italy.

Ever since the announcement last summer of the success of the Diesel motor, attention has been directed to the improvement of internal-combustion motors, and

the later applications of blast-furnace gases to the direct production of power in gas engines has formed the subject of articles nearly every month. The thermodynamics of the gas engines has received renewed attention, and these points all form subjects of papers in the recent technical press.

In municipal engineering the interest in bacterial processes of sewage purification continues, having formed the subject of an important paper before the British Association, and the method is being extended to new installations. The question of the prevention of smoke in cities is also receiving attention, and the example of Paris in enforcing reasonable smoke-prevention ordinances is likely to be followed by other large cities.

Automobile vehicles receive due share of notice in the technical press, the report of the Birmingham trials being made public in England, while the automobile-cab system of New York city has been extended by the addition of a number of new and improved vehicles.

Although the introduction of acetylene as an illuminating agent has progressed but slowly, new plants for the production of calcium carbide are being constructed both in Europe and America. It is a matter of some curiosity as to the disposal of the product of these works, for with the exception of the use of mixed acetylene and oil gas for the lighting of railway carriages in Germany, there seems to be an outlet for the carbide only in isolated and experimental plants.

The development of electric traction continues to be an important industrial and constructive matter, although nearly all the articles are simply descriptive of new installations, or deal with details of individual plants. The opening of the first three-phase electric tramway in France, at Evian-les-Bains, is made a subject of note in the continental press, and constructive features of overhead and underground conductors for electric roads are discussed.

In general railway work the controversy over the speed of trains seems to have been pretty well thrashed out, although some communications upon this well-worn subject still appear in the English press. In the United States the decision of the supreme court in the joint traffic association case is the subject of various editorials, it seeming to be the general opinion that while the decision is doubtless technically correct the practical results will not be to the benefit either of the public or the railways.

Internal waterways receive notice, especially in connection with existing and projected works on the continent, and comparative studies of land and water transport, as well as the improvement of river navigation, form the subjects of various papers.

An important paper upon the subject of the so-called fatigue of metals deserves attention in view of the severe service which many bridges and viaducts are called upon to endure, especially in the vicinity of great terminals, or in connection with local transportation in large cities.

In manufacturing establishments the questions involved in the management of labor and the best methods of shop accounting form features of constant discussion, and the important question of cost-keeping is expounded and discussed in several papers.

In the wide domain of mining and metallurgy the most notable contributions are those bearing on the successful working of gold by the cyanide process, including the electro-deposition method. There are also contributions to the development of the production of iron and steel, and the interest which has been developed of late in the safer use of mining explosives and in the prevention of disaster from firedamp is sustained in several important articles.

The whole work of the month, as recorded in detail in THE ENGINEERING INDEX, on pages 483 to 519 of this issue, shows a continuance of that increasing industrial activity which has been such a marked feature of the year, and which promises to extend into the coming year.

REVIEW OF THE ENGINEERING PRESS

Engineering in the United States Navy.

THE reports of the engineer-in-chief of the United States navy are always interesting reading, but that for the present year is especially valuable, coming as it does fresh upon the active service of the navy in the Spanish war. So many excellent points are made that to discuss them all here would involve reprinting nearly all of the original document, but the leading features at least will be noted.

One of the most important portions of the work of the bureau was that of completing repairs, equipping auxiliary vessels, and similar emergency work. This naturally brought out the deficiencies of the various navy yards, and must lead to improved equipment, use of modern tools, and general introduction of facilities for such emergencies.

In regard to the behaviour of machinery during action, most satisfactory results are reported for the vessels of the fighting squadrons:

"Even in action, when forced-draft conditions were in operation and the excitable natures of the men most wrought upon by the surroundings, the reports show that the machinery not only worked well generally, but that in no case was it greatly distressed. This is as fine a commentary upon the personnel as on the machinery.

"It is greatly to be regretted that the torpedo boats cannot show the same excellent records for their machinery, but it is a sad fact that nearly every one has had some accidents, and the machinery of some at the close of the war was in a condition which can only be described as horrible, where boilers were burnt, cylinder covers broken, pistons and valves stuck, and everything in bad shape. This condition of affairs seems attributable to two causes,—the absence of trained engineering supervision, and the use of the boats for duty to which they were not adapted."

The first of these causes arose out of the mistake of placing the highly organized pieces of machinery under the care of line officers, without engineering training and naturally unfit for such specialized duty. As to the second cause the improper use of the boats,—it should not have required experience to prove that this type of vessel can not be safely used for dispatch-boat duty and to act as tender to blockading ships far from base of supplies or facilities for efficient repair. Primarily, it is intended for high-speed spurts, where success or failure in the use of its special weapon will be quickly demonstrated. For this it is especially built, and for this it should be solely kept.

Among the noteworthy engineering features of the war may be noted the equipment and successful use of a floating machine shop as an integral portion of a fleet. The Vulcan, which was set aside for this purpose immediately on prospect of war, has proved a most successful experiment, and it is recommended that a similar vessel be fitted at once for service in the Pacific. Between July 1 and August 31 the Vulcan made repairs to 63 ships and supplied stores to 60.

Her unusual facilities and the large number of skilled mechanics on board (about 100) enabled her to make repairs of all kinds, including hull work, gun mounts, dynamos, main steam pipes, main piston rods (for small ships), brass castings without end, and iron castings in considerable quantity. This last is specially interesting as the first instance of the successful use of a cupola on shipboard.

The importance of distilling ships is emphasized, being important for cylindrical boilers, and absolutely necessary for water-tube boilers, and, although the two ships under equipment for this purpose were not ready before the close of hostilities, they have been successfully completed since.

In view of the discussion in England, it

is interesting to note the unqualified manner in which the use of water-tube boilers is endorsed in the report. In all the recent designs; except those of battleships, this type of boiler was specified, and it is now practically certain that water-tube boilers will be used in these also.

"The demands upon the engineer for great power on small weight, in order to secure the higher speeds for all classes of vessels which are now common, have practically ruled out the cylindrical boiler, on account of its weight and inability to carry the high pressures needed.

"The tactical importance of water-tube boilers is also being thoroughly recognized, and has been emphasized by the conditions which obtained in our blockade of Santiago and the great victory of July 3. It was necessary for a long period that our ships should be ready to develop maximum power at a few minutes' notice, and with cylindrical boilers this involved keeping all the boilers under steam, with heavily-banked fires and an attendant large consumption of coal. Water-tube boilers of the proper kind, which admit of the rapid raising of steam with safety, remove this difficulty, and give the commanding officer a more complete control of his fighting machine."

In closing, the engineer-in-chief gives his opinion as to the lessons of the war in connection with that portion of the work which came under his immediate department, and these are so important that we give them here in his own words:

"The war which has just ended is the first in which modern steam vessels have had a thorough trial, and it seems pertinent to note the more important lessons which have been taught by our experience. With respect to the machinery they are as follows:

"1. The vital necessity of giving the machinery of vessels in reserve frequent tests under working conditions, so that any defects may be discovered and remedied before war makes the vessels' services absolutely necessary. In several cases defects were found after the ships had begun cruising, and the repairs laid them up in the midst of the war.

"2. The great importance of having all our naval stations in positions of strategic value properly fitted out for repairs and with adequate supplies of non-perishable stores. It had been evident for a long time that Key West was such a station, but money to put in a proper repair-plant was refused year after year, and only granted after the war had begun. The movement of large bodies of troops and their equipment almost blocked the railroads, so that after the beginning of the war it was almost impossible to secure the forwarding of tools and supplies.

"3. That fresh water for the boilers is almost as important as coal, and that a distilling ship is an important adjunct of a fleet operating away from a base where fresh water can be readily obtained.

"4. That every fleet needs a repair ship to enable the efficiency to be maintained without leaving the station, and consequently that several ships should be equipped so as to be ready to proceed with the fleet.

"5. The great tactical advantages of water-tube boilers. This has already been discussed under another head.

"6. That, if more than two main engines are to be fitted, there should be three engines driving three screws, and not two main engines on each shaft. The New York and Brooklyn had their forward engines disconnected at the time of the Santiago fight, and could not stop to couple them. An accident to any part of either of the two engines on a shaft disables half the power; in the three-screw ship this fraction would be only a third.

"7. That there should be frequent trials under forced draft to keep the blowers in good condition and to make the men thoroughly familiar with working under maximum conditions. It appears that some of the ships had never been under forced draft since their contract trials until the day of the fight at Santiago.

"8. That the location of the forced draft blowers is a matter of serious importance. In some of our ships, owing to the demands for all other space for other purposes, the blowers had to be located in corners or pockets in the fire rooms, where

it was impossible for human beings to give them proper attention, owing to the intense heat due to lack of ventilation. In the Cincinnati temperatures as high as 205° Fahrenheit were noted, and the commanding officer, when investigating the case personally, had his face scorched. The blowers must be placed where they can be properly cared for, or else they are useless, and might as well be left on shore.

"9. That the personnel of the service should be adequate to the materiel. It has been notorious for some time that this is not the case, and we are providing for a decided increase in the number of vessels with no increase whatever in the personnel. By sending nearly every officer on the active list to sea we were able to give the regular ships a fair complement of trained ones, but, had the war been of long duration, we should have been greatly embarrassed to supply the places of those disabled or invalided. Volunteers, however well trained in other ways, cannot entirely replace the regular officer.

"10. That we must make provision for training the enlisted men of the engineer department. Many of the colliers and auxiliary vessels had to start out with absolutely green crews, many of whom, so far from having the 'sea habit,' had never been on a vessel of any kind. This must be remedied, if our enlarged fleet is to be efficient.

"11. That our fighting ships must have the highest practicable speed. There is an almost general agreement on this point among naval men, but, if any had thought that this did not apply to battleships, the fight at Santiago must have shown that the highest practicable speed is just as important in these vessels. It is very gratifying, therefore, that our three new battleships are to have speeds of at least 18 knots, which is now recognized as the standard."

The Melting-Point of Cast Iron.

IN a paper recently read before the Pittsburg Foundrymen's Association, and published in the *Iron Age*, Dr. R. Moldenke discusses the conditions which determine the melting point of cast iron, and also describes an ingenious modification of the Le Chatelier pyrometer, which enables it to be used to measure the temperature of molten metal in the ladle.

The pyrometer, as usually made, contains a thermo-electric couple formed of two wires, one of pure platinum and the other of an alloy of platinum with 10 per cent. of rhodium, these being enclosed in a porcelain tube to be inserted through the walls of a furnace and exposed to the action of flame or hot gases.

The instrument, as modified by Dr. Moldenke, is made with an iron tube for a portion of the length of the wires, this being bent 90 degrees and carrying at the end a clay tip containing the fused connection of the wires. This tip can be plunged into the molten metal and the correct temperature obtained almost immediately, while the construction is such that the clay tip can be readily replaced when necessary.

Although only a limited number of investigations have been made with this apparatus, Dr. Moldenke gives the tabulated results thus far obtained with pig irons, cast irons, steel, and some alloys and softeners, together with the chemical compositions.

The irons are arranged in the tables according to their combined carbon contents, and it is evident that, with few exceptions, the melting-points increase as the combined carbon goes down, this being the case independent of the amount of graphite present, the temperatures ranging from 2,030°F. for 3.98 per cent. of carbon, to 2,280°F. for 0.13 per cent. Alloys have a lower melting-point than that of any of their constituents; so also a white iron, really an alloy of carbon or some carbides of iron with iron, should melt sooner than the purer iron in the gray variety.

The tables show the melting-point of steel, for the specimens given, to be 2,450° and 2,350°F., and the fact that steel has a higher melting-point than that of the grayest irons shows that there are other considerations which affect this.

The difference in the melting-points of steel and gray iron may be due to the solution of the graphite in the iron before

the actual melting takes place, but this is offered only as a supposition; possibly further researches will throw further light upon the subject.

These investigations, it is hoped, are but the beginning of a more extended series, and, in view of the readiness with which the modification of the pyrometer makes it possible to do such work, the melting-points of many metals may be accurately determined.

Proportioning Cone Pulleys.

THE difficult nature of the problem of proportioning a pair of cone pulleys so that the length of the belt shall remain constant for any required set of speed-changes has caused numerous attempts to devise practical working methods for general use. Among these one of the very best is that given by Professor Reuleaux, in which Mr. Walter K. Palmer has made notable improvements, and in a recent issue of the *American Machinist*, Prof. Sweet discusses the whole subject, in the light of these latest methods and of those used by him many years before.

Cone pulleys are very generally used on lathes, in connection with a set of back-gears, so that, with four steps on the cone, for example, eight changes of speed are obtained; but with many lathes of older design these speeds are found to form a series with unequal intervals between the various members, a very irregular curve being formed when the speeds are plotted graphically.

This is especially the case in the change from the slowest speed with back-gear out to the fastest with back-gear in, there frequently being what is termed a "lump" in the speeds at this point. This is sometimes due to the use of a pair of cones designed for some other purpose, or to the use of an existing pattern with one step left off or an extra step added; and in any case this feature should be taken into account in designing a speed-change system involving cone pulleys and back gearing.

Professor Sweet has added to the work of Reuleaux and Palmer in a very practical way by showing how a curve may be plotted for any pair of cones which it may be desired to use, and how from this curve may be determined the back gear reduction which will give a regular gradation of speeds. Instead of selecting a ratio of back gear and endeavoring to design a pair of cones to suit, the ratio of speed-increase is first decided, from which the ratio of the back-gear can be found, and the system proportioned as a whole.

While the problem, considered as an example in applied geometry, is most interesting, and, as an exact solution, is in some cases very desirable, yet, as Professor Sweet points out, the practical limitations of the materials and data usually prevent a very precise determination.

One of the fundamental data required is that of the distance between the two cone pulleys, while in fact the pulleys must be made for machines which are to be used in various locations, and the distance between cones depends upon the height of ceiling or other local conditions, so that only an approximate degree of accuracy in proportions can be obtained for machines to be sold in the ordinary course of trade. When it is remembered, however, that a leather belt is so elastic a factor in the cone-pulley problem that a variation of one-tenth of an inch in the diameter of the pulley is of little consequence, it will be seen that the error due to a moderate variation in the distance between shafts is immaterial.

Professor Sweet's paper forms a very satisfactory supplement to Mr. Palmer's pamphlet, and is at the same time a desirable contribution to the history of the subject.

The Fatigue of Metals.

EVER since the experiments of Wöhler the subject of the so-called "fatigue" of metals has been discussed from various standpoints, and, although most engineers have acknowledged the deterioration indicated by those experiments, some prominent experts have denied such action. Thus, for example, no less an authority than Mr. Theodore Cooper maintained that the term "fatigue of metals" was "absurd and unscientific, and totally at variance with the acceptance of the perfect elas-

ticity of metals as heretofore accepted."

At the same time many others, of equally high reputation, accepted the theory of Wöhler, and have used the formula deduced from his experiments by Launhardt in proportioning framed structures.

One of the stanchest advocates of the theory of Wöhler is Mr. Henry B. Seaman, and, in a paper recently presented by him before the American Society of Civil Engineers on the Launhardt formula, he not only re-discusses the original experiments, but adds to them the results obtained by Bauschinger, deducing some additional relations which confirm the theory very fully.

Wöhler's experiments, made in 1870, showed that a repetition of stresses below the ultimate strength of the material finally causes rupture, from which it follows that a lower working stress should be allowed when the live load is a large proportion of the total load than that allowed when the dead load preponderates.

In the Launhardt formula the working unit stress may be determined for any given relation of live and dead load, and since 1882 the formula has been extensively used in America.

The most important result deduced by Mr. Seaman from his re-examination of the experiments is the fact that the effect of a live load applied repeatedly is equal to a dead load twice as great.

"Although the results are derived from experiments with different kinds of strain, and are too brief to permit the formulation of any definite theory, there seems to be ample basis for a general theory of work,—*i. e.*, that the material is capable of doing a certain amount of work (derived possibly from treatment, or work, which it receives in manufacture), and, when that amount of work is exceeded, the material becomes fatigued, and its tenacity finally destroyed. Under these circumstances the destructive effect of live strain may be considered as bearing a certain relation to that of dead strain, and in the experiments on wrought iron that effect would seem to be about in the ratio of 2 to 1 for all cases."

This fact makes the computation for the same load a very simple matter, and renders the application of Launhardt's formula unnecessary. All that is required is to double the live load and add it to the dead load, and, considering the result as all dead load, proportion the members accordingly.

It must be understood that this makes no allowance for the effect of impact and for the increase of compressive strains due to flexure of columns. For these Mr. Seaman recommends the column formula in general use, taking an allowable dead unit strain of 18,000 pounds. For alternate strains, however, the increase of compressive strain on the outer fibre due to flexure of column is found first, and then the compressive strain thus increased is added to the tensile strain, in order to find the total live strain.

In some instance it may appear that the dimensions deduced according to Mr. Seaman's method are unnecessarily great, but, when the conditions of many structures are carefully examined, the importance of providing for the actual working strains becomes evident.

"In outlining general specifications, provision must be made for extreme conditions. In the elevated railways of large cities, or in the large railway terminals, where the passage of trains is almost incessant. there is little rest for the structure; while the vibrations of all rapidly-passing loads, together with unbalanced drivers, flat car-wheels, and defective track, will increase the live strains very considerably in addition to the impact due to sudden application. When it is also remembered that, according to Bauschinger, it takes days, and perhaps weeks, for the material to recover fully from an applied strain, the ratio of 2 to 1 for dead and live strains does not seem to be excessively great."

The general acceptance of the truth of the condition of fatigue in metals renders Mr. Seaman's paper very acceptable at the present time, and the specifications for steel railroad bridges which form the appendix to the paper add to its value for the working engineer.

The Panama Canal.

THE interest which has been awakened in an isthmian canal is not confined to the Nicaragua project, and many still believe that Panama is the best point at which to construct the waterway between the two oceans. Much of the distrust which still attaches to the name Panama is due to the mismanagement and jobbery which proved the downfall of the original scheme, but since that collapse there has been a thorough investigation of the real merits of the project by a competent board of experts, and from the pen of a member of this commission, General Henry L. Abbot, there appears an excellent paper on the present status of the Panama Canal, published in *Engineering News:*

"The original plan contemplated placing the canal in the bed of the Chagres, and conducting the river to the sea through artificial channels. This project was long ago definitely abandoned, being replaced by the familiar system of locks and dams which has been so often successfully applied to other rivers. Careful measurements and studies of the regimen of this torrential stream have shown the system to be entirely applicable to it, and that none of the constructions demanded will exceed the limits of recognized engineering practice. To these advantages it should be added that two good harbors already exist at the Atlantic and Pacific terminals; that an American railway is in active operation, parallel and in close proximity to the line of the canal throughout its entire extent; that about 40 per cent. of the whole length has been actually excavated, and that great progress has been made on the intermediate portions; and, finally, that extensive preparations have already been made for accommodating the army of laborers which will be required on any isthmian canal. These reasons certainly demand that the comparative merits of this route should be considered before adopting any other location for the canal now generally believed to be essential to meet the needs of our Atlantic and Pacific coasts."

In comparing the relative merits of the Nicaragua and Panama projects, General Abbot gives maps and profiles of the two routes, showing that the Panama route is only one-fourth as long as the proposed Nicaragua Canal, while the constructive difficulties presented by the Nicaragua project are fully as great as those presented by the Panama project, and the bottom of the summit level is about twelve feet higher above datum in the Nicaragua profile than in the Panama.

One of the special obstacles supposed to exist in connection with the Panama scheme has been the regulation of the Chagres river, which, with its tendency to floods, has been supposed to offer especial difficulties. This matter has received careful attention from the Comité Technique, and the details of flow and the character of dams and overflow weirs proposed are described at length.

It is the opinion of the commission that the hydraulic problems presented by this turbulent river—at one time regarded as so serious—admit of satisfactory solution. This is hardly the case in Nicaragua, where one of the great difficulties of project is the regulation of a summit level depending on that of an immense lake 2,700 square miles in extent, receiving directly the drainage of 8,700 square miles of territory, together with that of 2,250 square miles more through the tributaries of the San Juan river above the dam at Ochoa,—conditions which render the ordinary method of storage reservoirs wholly inapplicable. Nevertheless, a delicate regulation of this level, and at an artificial height, is essential to avoid, on the one hand, drowning a cultivated district on the west shore, and, on the other hand, exposing rocks in the navigable bed of the San Juan. These difficulties are aggravated by the necessity of placing the overflow weirs near Ochoa, at a distance of more than 100 kilometres (62 miles) from the lake.

According to General Abbot, the careful estimate of the cost of completing the works at Panama, is, in round numbers, one hundred million dollars, and the time required is put at ten years. This is within the lowest of the Nicaragua estimates, and there appears to be no advantage in

economy in favor of the latter.

What Panama apparently needs is a complete assurance that none of the jobbery and blackmail of the old scheme shall adhere to it, and that the engineering problems be dealt with on a scale commensurate with their importance, the work being placed in honest and competent hands.

The Reconstruction of the Victoria Bridge.

A VERY interesting piece of engineering work, both from a professional and a historical point of view, is the reconstruction of the famous Victoria tubular bridge across the St. Lawrence at Montreal, and from an account given in the *Engineering Record* some particulars are abstracted.

The Victoria bridge, begun in 1852, and opened in 1859, has long been considered one of the engineering wonders of the world, not so much because of its particular novelty of construction,—for it was similar to the original tubular bridge at Menai strait,—as because it was the first great railway bridge built in America, was the longest and most costly bridge of its time, was designed by Robert Stephenson, and was opened by the Prince of Wales.

The most difficult portion of the work was that of the pier construction, the river being 22 feet deep, with an average current of 7 miles an hour, and the piers rising 40 feet above the surface of the water. These piers, somewhat widened, are retained, but the old tubular superstructure is replaced by pin-connected steel trusses, furnishing room for double railway track, two carriage roadways, and two footwalks. It is interesting to note that the new bridge has almost exactly double the weight of the old structure, while possessing five times the live-load capacity.

The papers in the *Engineering Record* contain much interesting information about the construction of the old bridge, taken from the somewhat inaccessible volumes published as a memorial at the time of the formal opening of the structure, but the matter of present interest is rather the manner of erecting the new trusses without interrupting travel through the old tubular spans.

This was accomplished by placing steel beams across the tops of the piers, projecting a short distance on each side. The end floor beams of each span were riveted with web connections to the ends of these beams, forming a box enclosing the top of the pier. Two trusses were then run out from the shore pier by the aid of a false-work span to make the first span, and an overhead traveller was constructed upon this, so that the trusses for the second span could in turn be erected and run forward.

The work thus progressed for successive spans, care being taken to impose no permanent load upon the old tube. Traffic was unobstructed, except for intervals of an hour or two, when the false work span and traveler were being moved. This method was duplicated from the other end of the bridge, a force of two hundred and fifty men succeeding in assembling and swinging nine 254-foot spans in one month.

The new bridge is now practically completed, and the old tube is being removed, so that the once famous Victoria tubular bridge is a thing of the past, although the original piers remain.

Electric Elevators.

THE increasing confidence which is being felt in the use of electricity for operating elevators is well shown by the adoption of this form for use on the Central London Railway, and a recent issue of *Engineering News* gives an excellent description of this, much the largest installation of electric elevators yet undertaken. The magnitude of the undertaking will be better understood when it is said that there are 14 stations with shafts from 18 to 30 feet in diameter and lifts ranging between 40 to 90 feet. The number of cars in each shaft is from 3 to 5, and the circular form of shafts and large loads (17,000 lbs.) required cars of very unusual shapes, thus adding to the difficulty of the work.

Owing to the opposition to the use of electricity and the pressure brought to bear in favor of hydraulic elevators, Mr. F. J. Sprague made several propositions to

convince the commission of the capability of electric elevators to meet the requirements, and the final acceptance of the electric type was made contingent upon the successful performance of a complete shaft equipment, to be tested during the progress of the main equipment. This preliminary plant, consisting of the equipment for an 18-foot shaft, sustained the very rigid tests in a satisfactory manner, and the work on the entire installation is being rapidly pushed to completion.

There is nothing especially new in the design of the elevators the work being rather an adaptation of old methods to meet the difficult requirements of the heavy service specified. The hoisting portion is of the winding-drum type, operated by duplex tandem worm-wheel system driven by electric motors of the four-pole enclosed railway type. When running at 470 revolutions per minute they give an elevator speed of 200 feet per minute, and when a descending car is loaded the motors generate and return current to the line.

Especial care has been taken to introduce efficient safety devices, there being not only a spring jaw clamp, but an oil-buffer system, together with electric limit stops for each car.

One of the requirements of the specifications was that an efficiency of 70 per cent. should be obtained, and in the contract test an efficiency varying from 70 to 75 per cent. was actually shown from the current at the brushes to the work on the ropes.

THE BRITISH PRESS

A National Physical Laboratory.

THE publication of the report of the committee of the treasury upon the subject of a national physical laboratory forms a most interesting contribution to general information as to the work which should be done at a public institution of this kind in England, and which is now being done in Germany and elsewhere; and, even if the recommendations of the committee are not at present adopted, the report is a valuable document in itself.

At the present time there are in England several places at which standards of various kinds can be compared, and a limited amount of original investigation work done. The Standards office and the Electrical Standardising Laboratory afford opportunity for the commercial comparison of ordinary devices for weighing and measuring, but are by no means equal to the far more delicate and difficult work involved in the origination of new standards.

The testing work carried out by a committe of the Royal Society at Kew observatory, including the rating of watches and chronometers, and the comparison of thermometers, barometers, and similar instruments, is excellent so far as it goes, but the limited means available naturally restricts the scope of this very useful institution.

In Germany the work of the two great institutions at Charlottenburg, the Physikalisch-Technische Reichsanstalt, and the Mechanisch Technische Versuchsanstalt has been conducted with such thoroughness and accuracy as to make the names of these laboratories known all over the world. In both of these instances the testing appliances are far more complete than those at present available in England, and it is well known that English manufacturers are frequently compelled to apply to these institutions for certain tests.

Their high reputations also give such value to the certificates which they issue that investigations which might be conducted at home are sent to Germany instead, and it must be admitted that, in respect of public institutions for scientific researches of this kind, Germany is far ahead of England. France also has the advantage of possessing the Bureau International des Poids et Mesures, although the work conducted there is confined to a limited field.

In order to provide for this deficiency in England, the committee submits a very practical and reasonable proposition. Taking Kew observatory as a basis, it is proposed to extend it into a National Physical Laboratory, by the addition of new buildings, the whole to be under the direction of the Royal Society in connection with the Board of Trade.

The idea is to establish a laboratory which shall not only undertake such public standardisation and research as may be officially required, but also make tests, comparisons, and verifications for private individuals on the payment of a fee, the institution being available for government departmental work as well.

The results of investigations undertaken at the request of private individuals should, except in special cases to be approved beforehand by the governing body, be published or be accessible to the public, even when the cost of the investigations is fully defrayed by the persons in question.

Whether such a laboratory will ever be constructed remains to be seen, but the character of the committee and the high standing of its members, together with the reasonable nature of its recommendations, give some cause for hope. Especially at the present time, when attention has been so generally drawn to the rapid commercial progress made by Germany as a direct consequence of the development of technical education, it is reasonable to suppose that such an institution might be regarded as a desirable, if not a necessary, investment.

Empire and Engineering.

A RECENT editorial in *Engineering* discusses in a decidedly comprehensive manner the important and close relation which engineering bears to political and industrial conditions,—a relation which is growing closer and stronger as the century draws to a close. "The engineer, not the mere political agitator, is thus the real revolutionist, and a little consideration shows that many of the social and economic problems of the present day are the results of his operations."

This is doubtless true of many countries, notably of the British Empire and of the United States, and it is interesting to note, even briefly, the great extent to which existing political relations are directly due to the advance of engineering works.

"Railways are most important factors in bringing about some of the political problems of the day. No one who has studied the question can doubt that the great Trans-Siberian Railway has been the cause of many of the troubles in the far east. Not only was Russia determined to have a port on the Pacific coast which was free from ice all the year round, but the changes and developments which are taking place in her industrial and commercial organisation, and the rapid increase in her population, compelled her to find an outlet for her products and her surplus people."

"If the Nicaraguan Canal were available, as it or some other similar undertaking is certain to be sooner or later, we should have a great revolution in the carrying-trade of the world." The changes which are taking place in the British colonies as well as in America indicate that in the not very distant future a great change in the position of the centre of magnitude of the world's trade and industry will be seen, and that Britain cannot hope to retain the proportion which she has hitherto held. Certain it is that, if Britain is not to be left behind in the transformations which are being wrought by engineering in political relations, she must take an active part in the work which is to exercise a controlling influence on trade and dominion.

The development of railways in India has hitherto been directed toward internal improvement and conservation, but it is now a question for serious consideration whether the time has not arrived for the construction of a railway which shall secure a short route and a rapid run to India. "Recent events in Africa have opened up great possibilities for the engineer, and it is safe to say that in a comparatively short time there will not only be a railway from Cairo to the Cape of Good Hope, but that the African continent will be intersected by railways in many directions, which will cause developments which are certain to have important results on industrial, commercial, and economic conditions."

Not only railways, but, even to a greater extent, the work of the shipbuilder and marine engineer affect the growth of empire. "It is curious to see how things hang together. The Spanish-American war in itself was a comparatively insignificant and one-sided struggle, but it marks an epoch, and in a sense completes the war between Japan and China, which revealed a new military and naval power. The more recent war is certain to leave its marks on history by the development of the fighting and industrial forces of the United States, and in both of these the engineer and the manufacturer will play an important part."

It is very certain that the political changes which have resulted in the displacement of mediæval methods of rule and life by those of the end of the nineteenth century will be followed by developments due to commercial enterprise led by engineering works and methods of thought, and that the military engineer will be followed closely by the civil engineer, to the great and lasting benefit of the scenes of his labours.

The Protection of Iron and Steel.

ONE of the most serious questions to be considered in connection with the increasing use of iron and steel for all kinds of structural work is that of protection against corrosion, the greater liability of steel to corrosion being especially a matter of importance.

On this account the paper presented re-

cently before the Society of Engineers by Mr. Sherard Cowper-Cowles upon protective metallic coatings for iron and steel is worthy of notice, and some extracts may be made bearing especially upon the principles which must be observed, if success is to be obtained.

The fundamental principle in the preservation of iron or steel from oxidation is the exclusion of air and moisture, which may be effected either by the use of non-metallic substances, such as the various protective paints, or by metallic coatings, such as zinc, cadmium, or copper. Mr. Cowper-Cowles devotes his discussion chiefly to the metallic coatings, since these, when properly applied, form the most effective means of protection, their use being recommended even when the work is to be painted.

If the coating could be made absolutely continuous, so that no air or moisture could penetrate to the steel, the action of the elements would be entirely transferred to the coating metal, and this, in all cases, is the result desired. It is practically impossible, however, to prevent the existence of pin-holes and similar microscopic breaks in the continuity of the coating, and, unless some additional protective feature be added, the oxidation will go on beneath the coating, the effect being all the worse because concealed.

The additional protection which can be afforded is that of galvanic action, by which such corrosion as is produced takes place upon the coating metal, and not upon the one which it is desired to protect.

This galvanic protection is best afforded by a coating of zinc, and it is mainly to methods of producing satisfactory deposits of this metal that Mr. Cowper-Cowles's paper is directed, although the use of cadmium, copper, and possibly aluminum is also considered.

"Iron coated with zinc, after a short exposure, becomes covered with a thin film of oxide, which gradually passes into a basic carbonate and adheres tenaciously, forming a protective covering to the zinc. So long, therefore, as the zinc surface remains intact, the underlying iron is effectively protected from corrosive action. The nature of the protective influence of the zinc on the iron is galvanic, zinc being electro-positive to iron. Two metals in contact in the presence of moisture form a galvanic couple, and the result of the galvanic action set up under these conditions is analogous to that which takes place in a galvanic battery,—*viz.*, the electro-negative element remains unaffected so long as the action continues, the intensity of the chemical action being governed by the relative positions of the two metals in the electro-chemical series."

It is important that the coating metal should be positive to the iron; else the galvanic action will accelerate the corrosion of the metal to be protected. Tin and iron, and copper and iron, standing some distance apart in the series, give rise to a decided galvanic action, in which the iron, as the electro-positive metal, is corroded more rapidly, if the continuity is once interrupted, than if it were not coated at all.

The ordinary process of "galvanising," as it is called, is well known to be the covering of the iron or steel with a coating of metallic zinc by immersion in a bath of the molten metal, and for many objects this method, used for so many years, is still well adapted. Galvanizing involves, as a preliminary to the production of a perfect coating, the removal of the mill-scale and the production of a clean surface, which result is usually accomplished by pickling in dilute sulphuric or hydrochloric acid. For sheet iron, or for articles in which strength is not a material feature, this is unobjectionable. It has been clearly shown, however, by the tests of Ledebur and by practical experience, that pickling materially reduces the strength of the metal. The cause of this action is not yet clearly established, although the experiments of Messrs. Johnson and Reynolds point to the possible combination of the iron with the liberated hydrogen and the formation of a brittle alloy.

These and other objections to the hot process of galvanising are avoided by the use of the cold process, in which the zinc

is deposited by a true galvanic action. When electro-zincing is adopted, the metal can be prepared by the use of the sand blast without the employment of acid, and tests have demonstrated that iron or steel coated with zinc by electro-deposition is not at all affected in strength. Mr. Cowper-Cowles gives numerous details which must be observed in order to insure success in the electrical deposition of zinc, and the increasing extent to which the process is being applied for boiler tubes, wire, and numerous articles of mechanical importance demonstrates that this method of coating is of much value.

In regard to the use of pigments for protection against corrosion some interesting points are brought to notice.

"Experience shows that pigments, usually metallic oxides or carbonates, act as carriers of oxygen from the air to the underlying iron, causing it to rust. An ideal paint should have a toughness which does not depend on a perishable ingredient; its elasticity should not be diminished by cold; it should not soften, but rather harden, by heat; it should contain no solvents but turpentine, which experience proves to be safe; and it should contain nothing which would act as a carrier of oxygen to the metal.

"The durability of painted ironwork, therefore, largely depends upon the surface of the metal being properly cleaned and prepared. An excellent surface in this respect may be obtained at a very small cost by 'zinc flashing,'—that is, coating the iron or steel, after pickling, with a thin coat of zinc, which will resist the effects of the weather, and retain a perfect surface for receiving a coat of paint until such time as it can be applied."

Methods of Dealing with Coal Dust.

COAL dust has always been one of the difficult subjects to be dealt with in mining, and various methods of dealing with it have been evolved. A paper in the *Colliery Guardian* reviews the progress which has been made in this direction during the past few years, showing the manner in which the problem has been attacked.

"From the moment that the coal is exposed in the face until it is sent to market it seizes every available opportunity to make dust, and naturally the softer and more tender the coal, the greater are its dust-forming proclivities. This goes on in the working-places in the operations of undercutting, breaking-down, and loading; during haulage and even during winding; at the surface in the tipplers, screens, belts, and loading shoots; and, finally, in the wagons or carts that remove it from the colliery. Suggestions have been made for attacking the problem at every one of these points, and most of them have been put to work in some locality or other."

In Germany, in the Saar district, the Meissner system has been used for dampening the coal before working it at all. This method employs boreholes which are plugged water tight, and into which water is forced under pressure and given time to soak into the coal. The result is that very little dust is brought down with the coal, and in some cases the boreholes made for this purpose can also be used in wedging down the coal. Where the nature of the coal will permit, this method is very effective, but for hard, non-porous coal, especially when there are many cracks, it is obviously impracticable.

In the operation of cutting the coal, more dust is produced by machines than is the case with hand cutting, and all that can be done in either case is to moisten the cuttings before they are loaded, both as a measure of safety and in order to keep the air of the mine pure.

When the coal is down and ready for loading into the tubs, is the usual time for the first effective application of water, and then the advantage of pipe systems is seen. Water can be brought into the face in any quantity by a hose, and used either before or after the coal has been loaded, the former practice having the advantage of preventing the dissemination of dust during the loading.

If the coal is wetted in the tubs a system of overhead perforated pipes may be used, a valve being struck as each car passes under, turning on the water momentarily and

sprinkling each tub to any predetermined extent. It is desirable that a minimum amount of water shall be used in any case, not so much to economise water as to avoid increase in the weight hauled, since it has been found in practice that the resultant total weight of water amounts to a very material addition to the load on a large output.

A proper wetting during or immediately after cutting greatly reduces the after formation of dust, and a judicious location of the tipplers and screens at the surface will prevent much dust from being carried down the shafts with the ventilation. General care in frequent removal of loose coal, shale and dirt from the floor will also prevent the formation of dust which would otherwise result from the grinding up of this loose material by car wheels and horses' hoofs.

All these precautions, however, will not prevent a gradual accumulation of dust in a mine, and unless some effective method is adopted for keeping it down it will become a certain source of discomfort and possible danger. Formerly salt scattered about in a dry or damp state was used for this purpose, and steam has also been employed, but both of these methods are now going out of use.

Salt water, on the other hand, has been widely adopted in the place of pure water, as it has two advantages over the latter. It keeps the dust moist for a longer time, and tends to form a crust over the dust or even to cause the whole mass to cake together. Water containing clay in suspension is also used in preference to pure water, as it has a binding action somewhat similar to that of salt water, but it cannot be prepared and used so easily, and water containing a small portion of cement distributed in it has been suggested. Various forms of spraying jets and watering carts have been devised for distributing the water, some of the carts having closed tanks containing compressed air to enable the water to be sprayed in all directions, and others being made with revolving sprinkling brushes.

By employing some of these methods, or modifications of them, much of the danger from dust explosions may be prevented, and by the use of similar precautions when the accumulations of dust are periodically removed, an important detail in coal mining may be successfully handled.

Relations of Employers and Employees.

A VERY thoughtful and interesting discussion of the important subject of relations between employers and employees is contained in the presidential address of Sir Benjamin C. Browne, delivered before the North-East Coast Institution of Engineers and Shipbuilders, and, in view of the conflicting opinions held in England and America, and the changing conditions of present workshop methods, his leading points are worthy of notice.

After showing that it is decidedly better for employers to deal with unions rather than with the men as individuals, representative action on both sides thus being had, the demands which employers are likely to receive from workmen are classified as follows: (1) demands which benefit the workmen, and are also beneficial or not injurious to the employer; (2) demands which are beneficial to the workmen, and which, at a greater or less sacrifice, the employers can afford to give; (3) demands which are beneficial to the workmen, but which the employers cannot afford to give, either on account of their own interests or on account of the trade; (4) demands which are not really beneficial, even to the workmen. In the first class, as examples, are mentioned the weekly payment of wages, the judicious regulation of over-time hours, and similar questions, which, although their introduction may cause the employer some inconvenience, ultimately are beneficial.

In the second class a reasonable demand for increased wages may be placed, while a demand for an increase above what the employer can possibly afford to give comes under the third head.

Under the fourth head come a number of points which have recently been in dispute, and which, when summed up, involve the right of the employers to the control of works. An excellent illustra-

tion of the necessity of concentrating the control in the hands of the employers is that of the man at the wheel on a steamship; just as no one is allowed to interfere with the man at the wheel, so workmen cannot be permitted to interfere with the management of works. This position includes the introduction of improved machinery, and the operation of several automatic tools by one man, as well as the employment of unskilled men upon modern tools not requiring the attendance of a trained mechanic.

An important question in this connection is that of the line of demarcation between one trade and another. As a matter of fact, there can be no strictly-defined line between one trade and another, as there is nearly always a margin in which both men are equally competent, and in such cases the employer ought to be entitled to employ either. A workman ought to be willing to do anything which can be properly done with the regular tools of his trade. Thus, either an engineer or a boiler-maker may cut a hole in a plate, but an engineer should not, as a rule, be asked to work on hot iron, because he has not been trained to it.

In discussing the losses which accrue to employers and workmen as a result of strikes, the point is properly made that the greatest losses are not those of wages to the men or of business to the employers, but the indirect losses to the country at large, and hence to many who have nothing to do with the contest.

Thus a manufacturer who cannot get his steam engine, or the shipowner who cannot get his ship to sea, are but examples of the indirect loss which falls upon third parties, while the permanent loss to the trade of the country by the diversion of trade elsewhere is the most serious of all, and is equally a loss to workmen and employers,—a curse to both, a blessing to neither.

The best possible remedy for labor troubles lies in the acquisition by the employees of an interest in the business.

"We may say that, for every workman employed in our trades, there is about £150 of capital invested, and, as the average wages paid (taking men, boys, and labourers) is about 30s. per week for 50 weeks, it means that the capital required per man is about two years' wages—much the same as it costs a man to buy his house. Now, it is not very difficult to see that, if any man saved up 10 per cent. of his wages for 14 years, and could invest the money at 5 per cent. compound interest, he would then have a sum equal to two years' wages, or, as I have said, to the capital that employs him. If only a few of our men would do this, it would be a step towards identifying our interests, and, besides that, the educational value of an investment is very great. You put money into something, and it is wonderful how quickly you will learn about it, and get rid of any unsound views you may have previously held. The workman-shareholder would be a connecting link between the capitalist and the workman, and, if the men held a large enough interest, a share in the management must follow."

Losses in Power Transmission.

IT is now generally appreciated that the loss in transmitting power from the point of generation to the point of application is very great, and that it often costs as much to get power to the tool as it does to utilize it at the machine. Additional figures upon this question, however, are always welcome, and some very interesting data upon the power consumed by shafting and belting are found in the paper upon the Midland Railway electric plant recently presented before the Institution of Mechanical Engineers by Mr. W. E. Langdon,

The main shaft is driven by belting from an Elwell-Parker motor, erected some years since. To drive the main shaft alone, quite free from belting, required an expenditure of 272 watts (0.36 h. p.) the shaft being 98 feet long, 2 inches diameter, with 12 bearings each 4⅜ inches long. To drive it with nineteen belts resting on it, but free from the tools, absorbs 518 watts (nearly ¾ h. p.); while the main shaft, belts, and countershafts together require 794 watts (1.06 h. p.). The power

required to drive a 9½ screw-cutting lathe without any cut, while all the other machines and belts were at rest, clear of the shafting, required 381 watts, while the power absorbed when the tool was turning down a bar of gun metal at the rate of 1.1 ounce per minute was only 545 watts, or at the rate of 495 watts per ounce per minute; or in other words the lathe running light consumed 381 watts, and the work done 164 watts.

By gearing an electric motor of low efficiency direct to the same lathe, and setting it to precisely the same description of work, the power consumed was at the rate of 214 watts per ounce per minute. In each case the greatest care was taken to insure equality in the cutting power, shape, and cut of the tool, and one cut only was made.

Comparative tests were made for one, two, and three cuts effected by the same lathe when driven from shafting, and when driven by a small motor, both being geared down to the same speed of lathe.

The advantage due to direct driving is clearly seen in the following results.

When driven by belting:—

Power..... 1,188 watts,
Metal cut..... 9.75 ounces
Time occupied.... 2.25 minutes

being an average of 275 watts per ounce of metal removed per minute.

When driven by motor direct:—

Power..... 616 watts
Metal removed..... 9.75 ounces
Time occupied.... 2.25 minutes

or an average of 143 watts per ounce per minute, thus showing the direct-connected motor to have about double the efficiency of the belt driving.

"The results would no doubt have been more interesting if obtained from larger tools, capable of doing heavier work. Under such conditions it is probable the waste of power in shafting and belting would not be so great in relation to the work done. Still it is clear that an extensive loss does take place, and that this may be reduced by driving each tool or machine direct from an electric motor. If every foot of the shafting and every machine connected with it were constantly at work without intermission of any kind, the difference would not be so marked; but this is just what does not happen. Shafting is extended down a long shop, and scores of tools are driven by it; whether they are all at work or not, the shafting has to be kept running. This entails a certain initial loss. With large tools, or machines absorbing over one horse power, there can be no question of the advantage derived from driving direct by electricity."

The Position of the Mechanical Draughtsman.

SOME time ago an editorial appeared in *The Engineer* calling attention to the position of the mechanical draughtsman, with especial reference to the high character of work expected, the very moderate pay given, and the grudging credit allowed for the ability displayed. The result has been a voluminous correspondence from both employers and employees, and a thrashing out of the subject from many points of view.

There can be no doubt that many draughtsmen are rendering good work for small pay, and that the chief who may have suggested the design and who expects to receive the credit for the completed work, very often neglects to mention the name of the lieutenant from whom he may have received most able assistance.

It should not be forgotten, however, that the position of mechanical draughtsman should be regarded, not as a permanent walk of life but rather as a state of probation in the training of the engineer, through which he must pass on his way to more remunerative and conspicuous positions. In the United States there is a saying that no one ever sees an old draughtsman, by which it is meant, not that the hard work kills them off, but rather that the draughting room is a place from which the engineering force is recruited, the ranks being filled by young men from the technical schools who again aim to acquire the practical experience which shall fit them for the work of designing and executing mechanical undertakings as competent engineers in charge.

This should be taken into account in considering the position of the draughtsman, and the possibilities of the profession ought to be included in the value of the time given to it. Taken as an ultimate occupation, there is nothing in the position of a draughtsman to attract either ability or industry, but when considered as a stepping stone to higher rank in the engineering profession, there is every inducement to hard work and varied experience.

At the same time there is undoubtedly too great a tendency for the men who are at the heads of works to ignore the share in their success which is due to their subordinates. As Professor Sweet wrote, many years ago: "There is a class of men who are never likely to have their merits justly appreciated. I refer to the great army of lieutenants—the chief draughtsman of the professional engineer, —the secretary of the society,—the professor's associate, the manufacturer's superintendent, the second engineer in the navy, the iron-master's assistant, the inventor's model-maker, the machine-shop foreman, the man to whom we always turn when we get in close quarters, the man who helps us out when we cannot find our way out ourselves. How readily the mind of the superior absorbs the thoughts and hints of his assistant, and imagines them to have been his own!"

THE CONTINENTAL PRESS

Further Experience with Acetylene.

SINCE interest in calcium carbide and in acetylene as an illuminant became so general, many applications on a large and small scale have been made, and innumerable devices have been proposed for generating and using the gas. Early in the history of the subject the well-known firm of Julius Pintsch, of Berlin, took up the investigation of acetylene, with a view of using it in connection with the illumination of railway carriages, and the results of the numerous experiments are now given in a paper in *Glaser's Annalen*, written by Dr. H. Gerdes, under whose supervision the investigations were made.

At the present time calcium carbide is sold in Germany for 30 to 40 pfennigs per kilogramme,—a price which may be lowered when the greater output of the numerous projected works is placed upon the market. This commercial carbide varies in value in proportion to its purity, and the average yield of acetylene from that now sold is 250 to 280 litres of acetylene per kilogramme, the theoretical yield from pure carbide being 340 litres.

The general rush to experiment with acetylene resulted in numerous disasters, so that warning soon was given as to its dangers. It was said to be very poisonous, to form dangerous detonating compounds with copper and copper alloys, and to be as readily explosive in the pure state as other combustible gases are when mixed with air.

These points have been carefully investigated, and the attempt made to arrive at the facts as they exist in practice. The poisonous nature of acetylene was readily tested, and it has now been clearly established that it is no more poisonous than ordinary coal gas. The second question, however, was not so readily settled.

A number of steel vessels were prepared and filled with alloys of copper with other metals, such as zinc, tin, nickel, etc., the alloys being made in the form of rods which could be filled in crosswise in such a manner as to expose a large amount of surface to contact with the gas. Each vessel was then filled with a different mixture of acetylene with oil gas, and with coal gas, and one was also filled with pure acetylene, at a pressure of 10 atmospheres, a small quantity of water being also added to insure the presence of moisture. The vessels were then permitted to lie on an exposed roof for nine months, subject to the heat and cold of summer and winter, after which a careful examination was made of the contents. The results were negative, no acetylides being found of any explosive character whatever. It was determined, however, that pure copper would form a detonating compound with acetylene, but only after long contact of the copper with large quantities of the gas,—conditions which are not met in practice.

It is now clearly established that pure acetylene does not explode at ordinary pressure, and that any decomposition or polymerisation effected by heat is not transmitted through the mass, but is limited to the point of application of the heat. Such explosions as have been caused by the application of heat to closed vessels containing acetylene have occurred only after the heating has caused such an increase in pressure as to permit explosion.

Under these circumstances it may be accepted that pure acetylene may be generated and stored in an ordinary gasholder with no more risk than is involved in similar work with the ordinary illuminating gas, and, so far as safety is concerned, it may be used freely when only reasonable caution is exercised.

Dr. Gerdes prefers to generate the gas by plunging the carbide into a comparatively large bulk of water, and in the apparatus which he shows there is little novelty other than in minor details of arrangement. Since the apparatus is designed for the generation of acetylene to be mixed

with oil gas for the purpose of storage in cylinders for use in lighting railway carriages, it is important that the predetermined mixture should be maintained. This is accomplished by the use of two meters, through which the oil gas and the acetylene are respectively passed, the drums of the meters being so geared together as to deliver the desired proportions of the two gases into the mixing main. The proportions usually employed are 75 per cent. of oil gas and 25 per cent. of acetylene,—a mixture which gives four times the illumination obtained from oil gas used alone.

To determine the danger of using the mixed gases compressed in cylinders, numerous experiments have been made, and it has been found that neither shocks or heating, within the possible limits of practice, produce explosions in mixtures containing less than 50 per cent. of acetylene, provided no oxygen is present. The assertion is distinctly made that there is no greater danger with the compressed mixture than with compressed coal gas, or even compressed air.

Herr Gerdes gives some interesting points about the production of phosphuretted hydrogen when impure carbide is used, and shows the importance of purifying acetylene generated from such material.

The Power Plant at the Paris Exposition.

THE department of motive power at the Paris Exposition of 1900, the plans for which are now made public in the *Genie Civil*, will be far more complete and extensive than has been the case at any previous exhibition, and for many reasons this portion of the display will be more attractive and interesting than has previously been possible.

In 1889 the various exhibits of steam generators were installed in temporary structures provided by the exhibitors, and the piping was conveyed in a somewhat independent fashion to the engines in the machinery hall; in the coming exhibition there will be a unity about the power plant which cannot fail to be a great improvement.

The total amount of power estimated as necessary is 20,000 h. p., of which 15,000 is allotted for lighting and 5,000 for motive power. This is only an estimate, which may be modified should occasion demand, but it is the basis upon which the present preparations are planned. Upon this assumption there is allowed a consumption of 440,000 pounds of steam per hour, or, for 205 days at 7 hours per day, a total of 631,400,000 pounds of steam for the entire period. It is estimated that this will require a consumption of about 200 tons of coal per day. The water required for condensing purposes is estimated at more than 280,000,000 cubic feet for the whole period of the exposition, and the arrangement adopted contemplates the use of this large volume of water in connection with a large cascade in the Champ de Mars.

The boilers are to be placed in two houses symmetrically disposed on opposite sides of the Champ de Mars, one of these being for French exhibitors and the other for foreigners, each boiler-house having its own chimney, and a system of flues beneath the ground permitting connection of every boiler with the chimney.

The unsatisfactory appearance of a number of separate chimneys, such as were seen in 1889, will thus be avoided, and the two great stacks can be designed to harmonize with the surroundings in such a manner as to add to the effect.

Owing to the character of the classification of exhibits, there will be a need for power in many widely-separated parts of the exposition grounds; hence the distribution of power must be effected almost entirely by means of electricity, shafting being adopted only in cases in which the driven machines may require it, and the shaft being then placed beneath the floor and driven by an independent motor. Thus there will be very little visible belt-driving, and consequently a marked improvement in the interiors of the buildings containing machinery.

In accordance with the idea of keeping transmission out of sight, all piping will be placed underground in subways constructed for the purpose. These subways, which will be nearly 9 feet in height and from 7 to 9 feet in width, and which are

now in process of construction, will contain the large mains for the delivery and discharge of the condensing water, as well as the general water-supply pipes and the steam mains, so that full access can be had at all times to any of the pipe systems without breaking ground; moreover, the inconveniences inseparable from the use of steam pipes laid directly under the floors will be avoided.

It is assumed that the quantity of steam demanded by the exposition will require at least 80 boilers, the adopted unit being a capacity of 5,500 pounds of steam per hour, and the boilers are to be placed back to back along the centre of the boiler-room, the smoke flues being in the centre, beneath.

The general arrangement under which the motive power department of the exposition is to be operated is that of a system of exhibits installed and operated by the exhibitors, and subject to all the rules of the exposition, the power to be paid for by the administration at regular predetermined rates. Each exhibitor is to bear all the expense of the installation of his plant, as well as the cost of its operation, and is to agree to keep it in operation during the 205 days of the exhibition (from April 15 to November 5). The remuneration for this service is to be divided into two parts: the sum of 1,500 francs for every 1,000 kilogrammes' productive capacity of steam per hour; the sum of 4.45 francs for every 1,000 kilogrammes of steam furnished for use. The pressure of the steam is to be 10 kilogrammes per square centimetre (142 pounds per square inch).

The generating units are to consist of steam engines and electric generators combined, each engine being required to be directly connected to its generator without the use of any belt or rope transmission. Each unit may be furnished by a single builder, or the engine may be furnished by one firm and the generator by another.

Three standards of current have been adopted, to which the generators are to be limited,—namely, a continuous current of 125.250, or 500 volts; an alternating current of 2,200 volts and frequency of 50; and a three-phase current of 2,200 volts and a frequency of 50.

As in the case of the steam generators, the remuneration for the electric power is divided into two portions, one for the plant and the other for the operation, as follows:

Installation, per h. p.	Engine.	Dynamo.	Total.
For each of the first 1,000 h. p.	9 95	4.08	14.03
For 1,000 to 1,500 h. p.	7.10	1.25	8 35
For all above 1,500 h. p.	5.20	0.95	6.15

Operation, per h. p. hour.	Engine.	Dynamo.	Total.
For each of the first 1,000 h. p.	0.00840	0 00707	0.01547
For 1,000 to 1,500 h. p.	0.00382	0.00293	0.00675
For all above 1,500 h. p.	0 0028	0 00240	0.00528

These figures, which represent francs, may be of interest in connection with the various rates charged for power elsewhere, in view of the general discussion of the cost of steam power.

Metallic Sleepers for Railways.

THE use of metallic sleepers has been discussed at much length upon various occasions, but the only wise judgment which can be formed upon so important a matter is that based upon long experience.

Nearly twenty years ago—*i. e.*, in 1880—this subject was taken up by the Liége-Limburg Railway, in Belgium, sections of the road being laid with metallic sleepers of various kinds, in order that definite information concerning them might be experimentally obtained.

A report upon the results of these tests is now made public in a communication to the International Railway Congress by M. Ch. Renson, and published both in the *Bulletin* of the Association, and in *Stahl und Eisen.*

Since 1881 the engineer of the Liége-Limburg Railway, M. J. W. Post, has taken each year some current pattern of sleeper and fastening, in many cases adding or suggesting practical modifications and improvements. Trial sections having been laid with the various styles of sleepers, these sections were specially watched and carefully maintained, a minute account of the time spent on their maintenance being kept. A comparative section of road laid with standard sleepers of sound oak was also watched under the same conditions, in order to furnish a basis

of comparison with the various experimental portions.

As might naturally be expected, the greatest defects were found in the form earliest laid, but even with this form there appeared distinct advantages over the oak sleepers.

In order to obtain a clear idea of the nature of the tests, a brief enumeration of the conditions must be given, and a fuller account will be found in the paper itself.

The ballast of the road is cinders, sand, or gravel, the rails being of steel, of the Belgian State pattern, weighing 77 pounds per yard, of lengths of 39½ and 29½ feet. Where the line is straight, there are thirteen sleepers to each 29½ feet, and ten sleepers to each 29½ feet, and, where there are sharp curves, there are one or two extra sleepers per rail. The heaviest engine weighs 68 tons, the heaviest load per axle being 13.9 tons, and the maximum permissible speed is 46½ miles per hour. During the seventeen years in which active experiments have been conducted the number of trains which have passed over most of the sleepers exceeds 100,000, and in one section, laid in 1881, more than 149,000 trains had passed up to January 1, 1898.

The earlier forms of sleepers were little more than a straight rolled channel, with holes punched to receive the bolts for holding the rails, and the subsequent modifications were at first mainly devoted to changes in shape and section.

On the comparative section which was laid with oak sleepers all of the 1,120 oak sleepers were withdrawn for various defects at the end of thirteen and one-half years, and the average life of oak sleepers on the road may fairly be taken at thirteen years. The corresponding average life of the earliest and crudest form of metallic sleeper was eighteen years; most of these failed from cracks originating in the punching of the holes and developing under the action of trains. Taking these inferior metallic sleepers in comparison with the oak sleepers, and allowing interest at four per cent. for the respective periods upon the first cost, it appears that the yearly cost of the oak sleeper is 41 centimes, and that of the metal sleeper is 19.5 centimes. The metallic sleepers, however, showed a higher cost for maintenance than those of oak, but, deducting for this, there still remained a yearly advantage of 10 centimes in favor of the metal sleeper.

A great portion of the loss of metal sleepers being due to cracks forming from the oblong punched holes, M. Post endeavored to use a sleeper which would permit the adoption of drilled holes and possess other improvements which experience had suggested. The result is a sleeper which has a greatly increased life, and which appears in many ways to be especially adapted for general use. This sleeper is rolled flat, and then stamped as a whole, to the required shape, in a hydraulic press, the material being a mild steel. A rectangular channel on the under side provides a recess which prevents the bolt-heads from turning, and an edge reinforcement is rolled in. The edges are turned down to form a channel-shaped sleeper, and the whole is constricted in the centre, thus increasing the rigidity in a vertical direction at the centre and decreasing the middle bearing surface. These two features greatly decrease the tendency to bend down at the ends, since the shape throws the greater amount of support under the rails, while the stiffer and narrower middle portion will sink into the ballast rather than compel the ends to bend down under the load.

The use of round drilled holes has effectually prevented the formation of cracks, and, by using square washers with eccentrically-placed holes the necessary adjustments can be obtained without making elongated holes through the body of the sleeper.

Intermediate wearing plates, placed between the rail and the sleeper, transfer the scoring due to the pressure of the rail to an easily-renewed piece, and add still more to the life of the sleeper, and with these modifications the Liége-Limburg experiments have demonstrated—to the satisfaction of M. Renson, at least—that metallic sleepers are cheaper, and in every way better, than those of wood.

Since none of the improvements added by M. Post have been patented, and since the earlier patented features described are now public property, there seems to be no good reason why, with the benefit of the experience thus freely given to the public, the use of metallic sleepers may not become general. The data and results are fully given in the report, the entire benefit of nearly twenty years' experience being thus placed at the disposal of all who may be interested.

Engineering Work on the Tiber.

THE question of river improvement has always received much attention in Italy, and there is probably no other country in Europe in which the maintenance of quay walls, the regulation of water-flow, and the general control of streams are better conducted.

A very full account of the engineering work which has been done along the historic banks of the Tiber is contributed by M. Ronna to the *Bulletin de la Société d'Encouragement*, and, while it contains nothing of especial novelty, it is an excellent example of the manner in which the rivers of Italy have been controlled from ancient times down to the present day.

After discussing the hydrography and hydrology of the Tiber and its basin, including that of the Anio, M. Ronna gives an interesting *résumé* of the history of the Tiber, gathering from many authors points of interest concerning its floods and the efforts of the Roman engineers to control them, and also illustrating and describing the ancient bridges, many of which remain, in restored and reconstructed forms. Recent work upon the river wall has revealed much of the original construction of the ancient Pons Aelius, and plans and sections of this old Roman masonry are given by M. Ronna.

Probably the most interesting historical point in connection with the Tiber of antiquity is the manner in which the shifting channel caused the ancient port of Ostia to be left on one side and to become an inland town.

Under the mediæval rule of the popes but little was done to improve the river, the maintenance of the banks being left to the occupants along its banks, but since 1870 the control of the river has been in the hands of the government engineers, and the progress since Rome has been the capital of Italy is clearly seen.

Rome naturally forms the dividing-point between the upper and lower river traffic, and thus there are two points, or ports, on the Tiber in the city, where the merchandise is handled. The upper port of Ripetta has recently been much improved, and a new bridge constructed across the river, but, since the upper stream is navigable only for boats of sixty tons or less, the greater part of the traffic occurs at the lower port of Ripagrande, from which there is a clear channel to the sea with a minimum depth of two metres. The bridges of the city obstruct traffic between the two ports, so that there is a space of more than two miles between them, and practically no water transportation of merchandise.

The most important modern engineering work on the river, however, is the entire walling-in of the river within the city limits, which, although planned during the French occupation before 1870, has been carried out since Rome was made the capital of Italy.

M. Ronna's paper contains numerous effective illustrations of the engineering features of the river, both ancient and modern, and forms an interesting contribution to the history of an important branch of engineering work.

The Water-Power of Italy.

ACCORDING to a note in the *Schweizerische Bauzeitung* the following interesting computation has been made of the total possible water-power available in Italy.

The surface of Italy is 236,402 square kilometres, and the annual rainfall is 0.8 cubic metres per square metre, which gives for the total yearly rainfall about 180 thousand million cubic metres.

Allowing one-third of the total to run off into the sea and one-third to be absorbed by vegetation and evaporated, there

remains one-third, or 60 thousand million cubic metres which is caught by springs and river sources at an average height of 200 metres above the sea. This latter corresponds in its fall to the generation of about 5 million horse power. At the present time there is in Italy about 400,000 steam horse power, and 600,000 hydraulic horse power, and assuming this to be replaced from that above computed there is still left 4 million hydraulic horse power undeveloped.

These figures give some idea of the wealth which is awaiting the application of capital and industry, the Italian peninsula being especially adapted by topography and position to utilize this natural wealth to the best commercial advantage.

The Artificial Cooling of Dwellings.

AT the recent convention of Heating and Ventilating Engineers at Munich an interesting paper upon modification of the heated atmosphere of summer by artificial cooling was presented by Herr Brückner, and the subject was discussed at some length, a report of the proceedings being given in the *Gesundheits-Ingenieur*.

The introductory portion of the paper reviews the various methods adopted to make the variations in climate less onerous to mankind, especially in the matters of warming dwellings in winter and the use of ice for household purposes in summer, and then proceeds to examine the possibilities of artificial cooling of the atmosphere in summer.

Two questions at once appear in connection with the cooling problem: the possibility of maintaining artificially a reasonably uniform cool atmosphere in summer, without producing too high a degree of humidity; and the possibility of doing so within a practicable limit of cost.

Artificial cooling at the present time is usually accomplished by some form of compression machine, these having very generally superseded the earlier forms of absorption machines. Herr Brückner goes somewhat into detail concerning the performance of the ammonia compression machine,—which is well-known in its construction and action and need not here be discussed,—and advocates for this especial purpose the ammonia machine with indirect brine circulation, the temperature of the brine not being necessarily as low as the freezing-point of water. A coil of pipe, with sufficient cooling surface, can readily be made to lower the temperature of the air, acting much as does the ordinary indirect system of steam-heating apparatus.

The question of humidity, concerning which there has been some discussion, is ingeniously treated by Herr Brückner. It is well known that the capacity of air for moisture is dependent upon its temperature, and that warm air requires a much greater amount of water for its saturation than does cold air. Warm air which is not fully saturated becomes saturated, therefore, when cooled below the dew point; and this effect is readily produced when a moist summer air is cooled by only a few degrees. If the air, however, is cooled to such an extent that much of the moisture is precipitated, either as dew or in the form of frost, a definite amount of the moisture is thus removed, and this cold air, when mingled with a portion of warmer air, will absorb moisture from it, and the cooling operation may thus be made a sort of drying process. It is this principle which may be used to avoid the production of an inconvenient degree of humidity in connection with artificial cooling. By cooling the incoming air in a chamber in which the coils are placed the temperature may be lowered to the dew point and a large portion of the moisture deposited, and then any desired degree of temperature and humidity may be obtained by mixture with incoming air, and the resulting atmosphere delivered to the apartments.

The question of cost is one which can be deduced only from existing refrigerating installations. While it is probable that a cooling plant at present would be too expensive for a single private residence, it is probable also that an installation for the service of a number of houses would bring the cost down to a reasonable price. At least, the plan is well worthy of consideration in connection

with hospitals and institutions in which the condition of the atmosphere plays so important a part in the treatment of disease, and for vessels in tropical climates some rational and manageable system of maintaining an endurable temperature should be possible.

Land and Water Transport.

THE question of the relative advantages of land and water transport for merchandise is one which must always be complicated with local conditions; but, as the varied conditions which surround existing roads and waterways often compare closely with those of projected works, the data obtained from experience in one location may be used for another.

An editorial review in the *Moniteur Industriel* discusses the question as it exists in France, making use of some data from the recent work of M. Colson, showing the conditions under which transport by rail should compete favorably with that by water.

Taking the coal traffic from the department of the Nord to Paris by canal, the cost, under the most favorable conditions, is about 0.01 francs per ton-kilometer, being as often above as below this figure.

On the French railways, under similar conditions, the cost per ton-kilometer is about 0.242 franc; but this figure is not properly comparable with that for canal transport. In the case of the railway the cost of transport includes a proportional share of the original cost of construction as well as the subsequent maintenance, while in France both the original cost and the maintenance of the waterways is borne entirely by the government. The figures for the railway also include the provision and maintenance of stations and terminals, with all the facilities for handling the merchandise, which are lacking in the case of the canal, and, when the proportional deductions are made for these portions of the cost, the two modes of transport show little or no difference in cost. In other words, in France at least, it is the shipper who bears all the cost of transport by rail, while with the canal a considerable portion of the expense is distributed among the tax-paying public.

When there is no competition between railway and canal, there is no good reason why the railway rates should be forced down, and, even where there is a waterway paralleled by a railway, there seems to be a general understanding that the rates by rail should be at least 20 per cent. higher than by water.

The question has arisen whether, when a railway is overcrowded, it is better to relieve the congestion by the construction of a waterway or by the addition of parallel tracks; M. Colson is plainly of opinion that, unless there is some very decided advantage in favor of the canal, such as the canalization of a convenient river, it is far better to increase the railway capacity.

In the same connection, a succeeding paper on the matter in which the navigation of the Rhine has been developed shows the commercial value of a natural waterway aided by judicious improvements.

The Rhine, in the course of its navigable length, contains seventy ports, of which fifty are places of commercial importance. These latter may be divided into three classes:

1. Those which serve as terminals for inland railways, and may be called ports of transit, such as Kastel, Bingerbruch, Homburg, and Gustavburg;

2. Ports of importation, such as Mannheim and Ludwigshafen, which are in communication with all the great ports of the world, and are really the terminals of the main navigation of the river;

3. Ports of exportation, such as Ruhrort, Duisburg, Hochfeld, etc., which furnish Amsterdam and Antwerp with return freights.

Between 1860 and 1894 there has been spent for improvements in the navigation of the Rhine more than 400,000,000 francs, of which one-fourth has been furnished by Holland and three-fourths by Germany. The work has all been executed according to a predetermined plan, under the direction of a special commission, and care has been taken that there should be at all times a general uniformity in the depth and capacity of the channel, the progress

on the various sections being controlled with that end in view.

The result of the improvement works has been a continued increase in the commerce of the river. In 1860 the tonnage of the Rhine in wooden bottoms was 1,581,781 tons, and in iron vessels 1,112,077 tons, while in 1890 the corresponding figures were 12,183,393 tons and 13,416,388 tons. A corresponding increase is observable in the number of steamboats, both for towing by direct haulage and by the chain drum system, and the general dependence of the increase of traffic upon increased facilities is fully demonstrated.

The cost of transport upon the Rhine corresponds very fairly with that on the French canals, averaging about 0.012 franc per ton-kilometer.

It must not be forgotten, however, when considering the importance of the traffic on the Rhine, that the river occupies a peculiar position. While it furnishes an important outlet for German products, it at the same time has at its mouth three ports of the first importance, which are in foreign territory. There is, therefore, in Germany a decided effort to divert as much of the internal water traffic as possible to the Elbe and the Weser, and thus promote the interests of the German ports of Hamburg and Bremen. At the same time there is a strong railway competition on both banks of the Rhine, which is under German control, and this causes the rates for the transportation of goods to be kept down to the lowest practicable scale.

These facts must be taken into account in making comparisons between the true cost of land and water transport from the experience obtained on the Rhine; but, when allowance is made for the local conditions, the true value of a highly-developed natural waterway may be fairly well determined.

THE ENGINEERING INDEX

INTRODUCTORY

This Index is issued separately from the Magazine, printed on one side of the paper only, and is supplied to subscribers for THE ENGINEERING MAGAZINE at a nominal charge of fifty cents a year to cover cost. In this form it meets the exact requirements of those who desire to clip the items for card-index purposes.

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The titles and addresses of the journals regularly reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated; W=Words; Anon=Anonymous.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa
Chem. Met Soc. of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, N. Y.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
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Electrician. *w.* London.
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Elektrochemische Rundschau. *b-m.* Frankfurt.
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Elektrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, O.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs. and Surveyors. Peoria, Ill.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash , D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienn
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, I l.
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club, Pro. Chicago, Ill.
Wiener , Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

College Buildings.

The New Buildings at Princeton University. The new library and new dormitory building are illustrated and described. 1700 w. Sci Am—Oct. 29, 1898. No. 23669.

Columbarium.

The New Columbarium of the Odd Fellows Cemetery Association of San Francisco. Alex. F. Oakey. Illustrated detailed description of a beautiful building designed for the permanent disposition of incinerated remains, as well as for cremation. 700 w. Cal Arch't—Sept., 1898. No. 23248 C.

Dome.

Steel Dome and Spire of St. Paul's Church, Chicago, Ill. An interesting example of structural steel-skeleton framework is illustrated and described. 500 w. Eng News—Oct. 13, 1898. No. 23336.

Grain Elevator.

American Grain Elevator on the Manchester Ship Canal. Illustrated detailed description of the construction of the buildings and their equipment. 3500 w. Engr, Lond—Oct. 7, 1898. No. 23418 A.

High Building.

Lord's Court Building. General illustrated description and supplement to specification. 1600 w. Arch & Build—Oct. 1, 1898. No. 23039.

Hospitals.

Sanitary Principles in the Construction of Isolation Hospitals. G. A. T. Middleton. With ground plans of numerous accepted arrangements, viewed especially from the architect's standpoint, and emphasizing the importance of cleanliness and ample ventilation. 2500 w. Engineering Magazine—Nov., 1898. No. 23599 B.

Residence.

Suburban Residence Built of Brick. Alfred B. Harlow. Illustrated description of a dwelling of moderate extent, costing ten thousand dollars. Gives also the ground plans, and describes the details. 2800 w. Br Build—Oct., 1898. No. 23677 C.

Surburban Residence Built of Brick. Edward B. Green. Illustrates and describes a beautiful home built at a cost of ten thousand dollars. 2200 w. Br Build—Sept., 1898. No. 23067 C.

Tenements.

Workmen's Dwellings. Discusses alterations dictated by sanitary science in apartments designed for the working class. 2000 w. Ill Car & Build—Sept. 23, 1898. No. 23120 A.

Town Architecture.

The Architecture of Our Large Provincial Towns—Newcastle-on-Tyne. An interesting illustrated description, with critical comment, and something of the history of the place. 7000 w. Builder—Oct. 8, 1898. No. 23425 A.

Warehouses.

Hamburg Warehouses. Edwin O. Sachs. One of a series of papers on "Fire Protection" published in *Engineering*. Describes and criticises these buildings from the fireproof point of view. Ill. 2400 w. Am Arch—Oct. 22, 1898. No. 23635.

HEATING AND VENTILATION.

Air Supply.

Ventilation and Warming. Extracts from a report by W. Napier Shaw, on the ventilation and warming in certain of the Metropolitan Poor Law Schools, giving the writer's views on ventilation. 3600 w. Arch, Lond—Sept. 23, 1898. Serial. 1st part. No. 23126 A.

American System.

Inlet or Outlet Ventilation. Lewis W. Leeds. Describes the system formerly used by the writer and found unsatisfactory, and also the present practice. 3300 w. Ill Car & Build—Oct. 14, 1898. No. 23600 A.

Fan System.

The Fan System of Heating and Ventilating as Applied to Court Houses. Describes the system, giving illustration. 1700 w. Dom Engng—Oct., 1898. No. 23642 C.

Greenhouses.

Greenhouse Heating. Thomas N. Thomson, in the *Home Study Magazine*. Brief description of a small greenhouse and the means of heating it, that may be built by any man handy with tools. Ill. 1500 w. Sci Am Sup—Oct. 8, 1898. No. 23237.

Hotel.

The New Mills Hotel, New York City. Describes briefly the plan of Mills House, No. 2, giving illustrated description of the ventilation and heating plant. 2000 w. Eng Rec—Oct. 8, 1898. No. 23188.

Railway Station.

The Heating and Lighting Equipment of the Grand Central Station, New York. Illustrated description of the plant. 1200 w. Elec Wld—Oct. 1, 1898. No. 23087.

Recent Systems.

Recent Systems of Heating and Ventilation. R. C. Carpenter. Presents the advantages of the mechanical system. Part first is introductory to a study of the different forms of fans and of the experiments which have been made relating to their use. 1800 w. Heat & Ven—Oct. 15, 1898. Serial. 1st part. No. 23670.

Residence.

The Combination Heating and Sanitary Plumbing of a Residence. Illustrates and describes the heating and plumbing systems of a commodious residence. 2300 w. Met Work—Oct. 15, 1898. No. 23349.

School House.

School House Warming and Ventilation. S. H. Woodbridge. Discusses the peculiar con-

ditions of the problems and their solution. 3200 w. Eng Rec—Oct. 22, 1898. Serial. 1st part. No. 23630.

PLUMBING AND GASFITTING.

Bath Heaters.

German Bath Heaters. Robert Grimshaw. Illustrates and describes water heaters in use in Germany. 3000 w. Dom Engng—Sept., 1898. No. 23057 C.

Brass Goods.

Making Plumbers' Brass Goods. Charles Vickers. Condensed from paper read at the Cincinnati meeting of the Am. Foundrymen's Assn. Suggestions for making machinery brasswork. 1000 w. Dom Engng—Sept., 1898. No. 23056 C.

Columbia University.

Plumbing Details in Columbia University Gymnasium, New York. Illustrated description of filters and hot and cold water system for swimming bath. 1000 w. Eng Rec—Oct. 1, 1898. Serial. 1st part. No. 23160.

Drains.

Some Causes of Stoppages of Drains. William A. Murray. Calls attention to points requiring care. Ill. 1700 w. Dom Engng—Oct., 1898. No. 23641 C.

Hotel Plumbing.

Plumbing in the New Mills Hotel, New York City. Illustrated description of work in a building for men earning small wages. 2000 w. Eng Rec—Oct. 15, 1898. No. 23360.

Leaks.

Leaks in Plumbing Work in Connections of Water Front and Range Boilers. A. W. Murray. Explains the causes that produce these defects. 1700 w. Dom Engng—Oct., 1898. No. 23640 C.

Ordinance.

Plumbing Ordinance in Wilkes-Barre, Pa. A copy of the ordinance regulating plumbing and sanitary matters which has been in force since July 20, 1898. 3000 w. San Plumb—Oct. 1, 1898. No. 23199.

Regulations.

Scotch Plumbing Regulations. From the *Plumbers' Review.* Extracts from a pamphlet of regulations intended to be applicable to Scotland only, but containing much of general interest. 3700 w. San Plumb—Oct. 15, 1898. No. 23639.

Sanitation.

Modern Sanitation. W. Henman. Address before the Engng. & Arch't. Section of the Sanitary Institute Congress at Birmingham, England. General remarks on the importance and progress, with consideration of plumbing, ventilation, and related subjects. 3500 w. Builder—Oct. 1, 1898. No. 23267 A.

MISCELLANY.

Addresses.

President's Address before the British Architectural Association. G. H. Fellows-Prynne. Reviews the past work of the Assn. and states the needs and aims of the future. Discussion. 12,500 w. Builder—Oct. 15, 1898. No. 23601 A.

The Architectural Association School of Design. Abstracts of addresses by the President of the Association, and by Aston Webb, with editorial comment. 5500 w. Builder—Oct. 15, 1898. No. 23602 A.

Altar.

A Bomos in Sabina. Settimio Giampietri. Illustrates and describes an old Pelasgic altar for sacrifice. 2300 w. Jour Roy Inst of Brit Arch'ts—Sept. 24, 1898. No. 23497 B.

Architectural Competition.

An International Architectural Competition. Summarizes the purposes and results of the preliminary competition for the University of California buildings. 1500 w. Eng Rec—Oct. 15, 1898. No. 23354.

Building Stones.

Tests of Iowa Building Stones. Anson Marston. From report of Proceedings Iowa Engng. Soc., Jan. 19, 1898. Tests made under the direction of the writer by students of the Iowa State Agricultural College. Results are given. Ill. 2000 w. Stone—Oct., 1898. No. 23486 C.

Use of Stone in Building. H. F. Bain, in Annual Report of Iowa Geological Survey for 1897. The selection of stone, the conditions of life which affect stone buildings, &c. 1400 w. Stone—Oct., 1898. No. 23488 C.

Church.

The Church of the Redeemer, Jerusalem. From the London *Times.* Brief historical account of the church to be dedicated by the German Emperor on Oct. 31, 1898. 1000 w. Arch, Lond—Oct. 14, 1898. No. 23494 A.

Collapsed Building.

The Govan Building Disaster. Report of the official investigation with regard to an accident to an uncompleted building in Scotland, which killed five men and injured three. 2800 w. Arch, Lond—Oct. 14, 1898. No. 23493 A.

Columns.

The Strength and the Safe Load for Cast Iron Columns. (Die Bruchlasten und die Zülassigen Belastungen Gusseiserner Säulen.) F. v. Emperger. A general review of the experiments recently made in New York, together with a comparison of the various formulas for the strength of columns with the actual results obtained. The injurious effect of eccentric loading is emphasized. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 1, 1898. No. 23529 D.

Cooling.

The Application of Refrigerating Machinery for Cooling the Air of Dwellings. (Die Verwendung von Kältemaschinen zur Lüftung von Wohnräumen.) Dr. Brückner. A discussion of the practicability of cooling the atmosphere of dwellings in heated climates by the use of artificial refrigeration, within a reasonable limit of cost, and without producing excessive humidity. 6000 w. Gesundheits-Ingenieur—Sept. 30, 1898. No. 23533 B.

Cut-Stone.

Machine vs. Hand-Cut Stone. F. R. Patch. A defense of the machine. 1100 w. Stone—Oct., 1898. No. 23485 C.

Doorways.

Two South-Saxon Doorways. J. Tavenor Perry. An account of two interesting, undoubted Saxon doorways near Brighton, Eng., with sketches. 1700 w. Jour Roy Inst of Brit Arch'ts—Sept. 24, 1898. No. 23496 B.

Elevators.

Novel Elevator Plant in the Standard-Oil Building, New York City. Illustrated description of hydraulic elevators of unusual economy and design. 2600 w. Eng Rec—Oct. 22, 1898. No. 23627.

Exposition.

The Trans-Mississippi Exposition. Octave Thanet. A description of the exhibition, giving many illustrations of buildings, and other exhibits. 4000 w. Cos—Oct., 1898. No. 23071.

Illumination.

On the History of Our Ideas Concerning Illumination. Henry Crew. Reviews the history of windows and of the progress in artificial lighting, covering twenty centuries. 2300 w. Am Arch—Oct. 1, 1898. No. 23149.

Italy.

Unknown Italy. William H. Goodyear. An interesting illustrated account of the Italian architecture in unfrequented territory, giving some facts showing the isolation and backwardness of many of the places, and other matter of interest. 4800 w. Arch Rec—Oct.-Dec., 1898. No. 23656 C.

Metal Protection.

See Civil Engineering, Miscellany.

Mistakes.

Some Mistakes of Contractors as Viewed by an Architect. F. E. Kidder. The first of a series of articles on the mistakes of building contractors. Part first discusses the mistakes of bidding too low, and the matter of time. 1200 w. Br Build—Oct., 1898. Serial. 1st part. No. 23678 C.

Notable Buildings.

The Villa Lante. Edwards Gale. Illustrated description of the ornamental gardens, fountains, terraces, &c. 1700 w. Arch Rec—Oct.-Dec., 1898. No. 23655 C.

Organs.

Organ-Building. H. Heathcote Statham. Considers a recent work by F. E. Robertson on how to build an organ. 4000 w. Jour Roy Inst of Brit Arch'ts—Sept. 24, 1898. No. 23495 B.

Repairs.

Repairing Buildings. Illustrated description of the repairs of a 3-story brick building, leaning seriously, and of the removal of iron columns and reconstruction of trusses in a 4-story building 68 ft. wide and 100 ft. long. 1000 w. Eng Rec—Oct. 22, 1898. No. 23629.

Roman Palace.

Raphael's Palace at Rome. Interesting information of this building, giving its history and gradual transformation to the present condition. 2200 w. Am Arch—Oct. 15, 1898. No. 23401.

Sanitary Papers.

The Sanitary Institute Congress, Birmingham. Abstracts of a series of papers read at the recent Congress on ventilation, drainage, water, sewage, &c. 5000 w. Builder—Oct. 8, 1898. No. 23426 A.

Stained Glass.

Concerning Stained Glass. Review of a recent book by Lewis F. Day, giving extracts and abstracts. Ill. 3500 w. Builder—Sept. 24, 1898. No. 23216 A.

CIVIL ENGINEERING.

BRIDGES.

Arches.

Hartford Memorial Bridge and Arch. Illustration and brief note relating to one of the handsomest stone-arch bridges in the United States. 200 w. Stone—Sept., 1898. No. 23035 C.

The Arch Bridge over the Niagara Rapids. (Die Bogenbrücke über die Niagara-Stromschnellen.) G. Barkhausen. Illustrated description of the new Niagara railway arch based upon the paper of the engineer Mr. R. S. Buck. 6000 w. Zeitschr d Ver Deutscher Ing—Oct. 1, 1897. No. 23528 D.

The Computation of Stresses in Monier Arches. (Ueber die Berechnung der Spannungen in den Moniergewölben.) M. R. v. Thullie. A thorough mathematical discussion of the subject, reviewing the theories of Spitzer and Monier, and giving practical applications of the formulas. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 23, 1898. No. 23520 B.

The New Metal Arch Bridge at Niagara. (Le Nouveau Pont Metallique en Arc sur le Niagara.) Raymond Godfernaux A very excellent description of the new railway arch across the Niagara gorge, with comparisons with numerous arches on the continent, and especial reference to the Viaur Viaduct. 3500 w. 1 plate. Le Génie Civil—Sept. 24, 1898. No. 23501 D.

Bridge Disaster.

The Fall of a Bridge at Cornwall, Ontario. Illustrated account of a disaster in which a river pier and two adjacent spans fell, with such facts as have been learned as to the cause. 1200 w. Sci Am—Oct. 1, 1898. No. 23086.

Bridge Floor.

A New Brick and Concrete Bridge Floor and Roadway. Illustrates and describes a brick and concrete roadway and sidewalk bridge under construction at DeKalb, Ill. 700 w. Clay Rec—Sept. 26, 1898. No. 23399.

Budapest.

The Francis Joseph Highway Bridge over the Danube at Budapest. (Le Pont-Route François-Joseph sur le Danube à Budapest.) A very complete account of this important cantilever, with details of the piers, structural work and erection. 4000 w. 1 plate. La Revue Technique—Sept. 25, 1898. No. 23510 D.

Distortion.

The Sectional Distortion of Iron Bridges. (Die Querschnittsverzerrungen Eiserner Brücken.) O. C. Reymann. A mathematical discussion, showing the effect which a distortion of a cross-section has upon the vertical and longitudinal members. Serial. Part 1. 4000 w—Glaser's Annalen—Oct. 1, 1898. No. 23543 D.

Exposition.

The Universal Exposition of 1900. (Exposition Universelle de 1900.) Giving an account of the present state of the works, and especially of the false works for the erection of the superstructure of the Alexander III. bridge without obstructing travel on the Seine. 3000 w. La Revue Technique—Oct. 10, 1898. No. 23514 D.

Foundations.

Bridge Foundations. A statement of the precautions which should be taken. 900 w. Eng Rec—Oct. 1, 1898. No. 23155.

Deep Bridge Foundations, Atchafalaya River. C. H. Chamberlin. Facts regarding this work in an alluvial section, where unusual depth of the piers was made necessary by reason of the instability of the soil when acted upon by river currents. Diagrams. 3200 w. Jour Assn of Engng Soc's—Sept., 1898. No. 23705 C.

Highway.

Highway Bridges. Editorial on methods of securing safe county bridges. 1600 w. Eng Rec—Oct. 15, 1898. No. 23353.

Launhardt Formula.

The Launhardt Formula, and Railroad Bridge Specifications. Henry B. Seaman. Reviews Wöhler's experiments on the fatigue of metals and the deductions which were made in 1889, placing the matter in a form for practical application to bridge construction, presenting a general specification for steel railroad bridges. 8000 w. Pro Am Soc of Civ Engs—Oct., 1898. No. 23654 F.

Maintenance.

Care of Bridges. Extracts from the committee report on this topic to the Assn. of Supts. of Bridges and Buildings. 900 w. R R Gaz—Oct. 28, 1898. No. 23689.

Modern Bridging.

The Birth-Place of Modern Bridging. The history of the first successful building of iron bridges by the Coalbrookdale ironmasters, in 1779. Ill. 1300 w. Engr, Lond—Sept. 23, 1898. No. 23142 A.

Montreal.

Reconstruction of the Victoria Tubular Bridge, Montreal. An account of the work of rebuilding the tubular bridge at Montreal, giving facts of interest relating to the old bridge and some idea of the cost. Ill. 1200 w. Ry & Engng Rev—Oct. 1, 1898. No. 23220.

The Victoria Bridge, Montreal. Illustrated description of the old and new bridges. Part first is on the conditions governing the work and the construction of the piers. 4500 w. Eng Rec—Oct. 22, 1898. Serial. 1st part. No. 23624.

Pontoon Bridges.

Old Methods of Crossing Rivers by Pontoons. Gives illustrated descriptions of boats and methods used. 900 w. Sci Am Sup—Oct. 22, 1898. No. 23467.

CANALS, RIVERS AND HARBORS.

Bruges.

The Harbor and Maritime Canal of Bruges. (Les Ports et le Canal Maritime de Bruges.) An account of the extensive harbor improvements recently commenced, and to be completed in 1902, at a cost of nearly 40,000,000 francs. 1200 w. La Revue Technique—Sept. 25, 1898. No. 23509 D.

Canal Locks.

The Electrical Operation of the Locks of the North Sea Canal between Ymuiden and Amsterdam. (Der Elektrische Betrieb der Meerschleuse des Nordseekanales von Ymuiden nach Amsterdam.) F. Tischendörfer. A very complete account of the canal locks, with illustrations of the electrical windlasses, capstans and other apparatus by which they are operated. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 24, 1898. No. 23525 D.

Cedar River.

Gauging of Cedar River, Washington. Theron A. Noble. An explanation of methods used and data obtained in preparation for the installation of a water-power plant on Cedar River, the object being to transmit power to Seattle and Tacoma. Ill. 3500 w. Pro Am Soc of Civ Engs—Sept., 1898. No. 23065 F.

Dock.

A Remarkable Dock. Describes the hull of an old ship of about 800 tons which was sunk in the mud to be used as a dock, and also the new dock which is to replace it. 1000 w. Engr, Lond—Sept. 30, 1898. No. 23292 A.

Dredges.

Steam Barges, Suction Dredges, and Bucket Dredges. (Porteurs à Vapeur-Dragues à Succion, Dragues a Godets.) Especially devoted to recent French dredges constructed for use in Russia. 2000 w. La Revue Technique—Oct. 10, 1898. No. 23513 D.

Erie Canal.

New York's Canals. State engineer, C. W. Adams, discusses the report of the Canal Investigating Commission. Also editorial. 4500 w. Sea—Oct. 13, 1898. No. 23351.

Recent Engineering Work on the New York State Canals. Review of the State engineer's reply to criticisms on the preliminary work for enlarging the canals, the choice of specifications and the classification of rock and earth. 4800 w. Eng Rec—Oct. 22, 1898. No. 23625.

Flume.

The Basic Company's Flume, Idaho. Illustrated description of this work and its construction, in connection with the installation of a water-power plant at Grimes Creek to furnish electric power needed at the company's works. 2000 w. Eng & Min Jour—Oct. 15, 1898. No. 23404.

Haulage.

See Electrical Engineering, Power.

Hydrometry.

The Williams Hydrometric Cord. (Le Cordage Hydrometrique Williams.) An improved device for determining the velocity of flow in a stream by measuring the angles of deflection of the catenary formed by a cord attached, under known tension to the banks of the stream and subject to the force of the current. Formula and illustrations are given, and accurate results claimed. 1200 w. La Revue Technique—Oct. 10, 1898. No. 23515 D.

Lighthouses.

The Latest Improvements in the French Lighthouse System. Jacques Boyer. The second paper gives a very full account of the great Eckmühl lighthouse on the Breton coast, and concludes with a discussion of lightships and illuminated buoys, with many illustrations. 3500 w. Engineering Magazine—Nov., 1898. No. 23596 B.

Nicaragua Canal.

The Nicaragua Canal. Day Allen Willey. Discusses the route, the topography, the difficulties in construction, cost, the effect on commerce, and in developing the western coast of the United States. 2800 w. Chau—Nov., 1898. No. 23681 C.

See Economics and Industry, Commerce and Trade.

Panama.

The Panama Canal. Statement of work done by the international committee of engineers. 900 w. Eng Rec—Oct. 1, 1898. No. 23156.

The Present Status of the Panama Canal. Henry L. Abbot. Sets forth the work of the international engineering commission which visited and inspected the works on the Isthmus and examined the engineering problems, with the conclusions they reached. Also editorial. Ill. 5500 w. Eng News—Oct. 6, 1898. No. 23244.

Rhine.

The Regulation of the Rhine. (Die Rhein-Regulierung.) P. Krapf. A very complete account of the correction of the Rhine above the Lake of Constance with plates of maps, profiles, canal sections, and dredges. 6000 w. 4 plates. Oesterr Monatschr f d Oeffent Baudienst—October, 1898. No. 23534 D.

The Rhine (Le Rhin.) A review of the growth of traffic on the Rhine and some account of the improvements which have increased the navigable capacity of the river. 1800 w. Moniteur Industriel—Oct. 1, 1898. No. 23566 G.

Tiber.

The Tiber. (Le Tibre.) M. Ronna. An historial and technical review of the engineering works on the Tiber, from ancient times down to the present, including bridges, quays, harbors, and the general hydrography of the stream. An interesting and valuable paper. 25,000 w. Bulletin de la Société d'Encour—Sept., 1898. No. 23516 G.

Tidal Rivers.

Characteristic Particulars about a Tidal River. Leveson Francis Vernon-Harcourt. Summary of the various particulars of a tidal river, which are of importance in determining its precise condition, and enabling its capabilities for navigation to be compared with those of another river. Ill. 5500 w. Ind Engng—Sept. 17, 1898. No. 23468 D.

IRRIGATION.

Dam Failure.

The Failure of the Snake Ravine Dam, Turlock Irrigation District, California. J. B. Lippincott. Gives the history of this dam, with comments on the Wright Act, which provides for district irrigation in California. Ill. 1800 w. Eng News—Oct. 20, 1898. No. 23457.

Report.

The Sind Irrigation Report, 1896-97. A. R. Gives a short history of the Sind Irrigation Works, and a favorable report for the year. 1400 w. Ind Engng—Sept. 3, 1898. No. 23200 D.

Temperature.

The Temperature of Irrigation Fields. A review of observations with soil thermometers showing how irrigation affects temperatures. 900 w. Eng Rec—Oct. 29, 1898. No. 23693.

MISCELLANY.

Cement Testing.

German Methods of Testing Cement. Translation of articles in the official organ of the International Society for the Unification of Tests of Materials. 2200 w. Eng Rec—Oct. 15, 1898. No. 23356.

Cement Works.

Buckeye Portland Cement Plant Near Bellefontaine, O. Illustrated description of a plant which began with Dietzsch kilns and the semi-humid process and now uses wet grinding and continuous rotary kilns burning powdered coal. 1400 w. Eng Rec—Oct. 15, 1898. No. 23355.

Columns.

See Architecture and Building—Miscellany.

Engineering.

See Economics and Industry, Commerce and Trade.

Metal Protection.

Lead vs. Zinc Paints. G. R. Henderson. An account of a series of exposure tests on tin, galvanized iron, sheet iron, poplar, white pine, and yellow pine. Two coats of paint were given to each. Reports results. 900 w. R R Gaz—Sept. 30, 1898. No. 23081.

Methods of Rust Prevention. (Die Mittel zur Verhütung des Rostes.) Dr. Julian Treumann.

A general discussion of various methods of rust prevention, with especial reference to structural steel and iron work. Two articles. 6000 w. Stahl und Eisen—Oct. 1, 15, 1898. No. 23564 each D.

The Protection of Metal Work in Concrete. Letter from Albert W. Buel. A compilation of statements claiming that paint is unnecessary. 1400 w. Eng Rec—Oct. 8, 1898. No. 23187.

Protective Metallic Coatings for Iron and Steel. Sherard Cowper-Coles. Read before the Soc. of Engs., England. Part first considers the causes that tend to corrode iron and steel, and will later deal with the processes for applying metallic coatings which effectively exclude air and moisture. 2300 w. Ind & Iron—Oct. 7, 1898. Serial. 1st part. No. 23412 A.

Roads.

Road Building. An informal discussion before the Society, printed that the views expressed may be brought before all the members. 16,500 w. Pro Am Soc of Civ Engs—Oct., 1898. No. 23653 F.

Tornado.

The Merriton Tornado. Orrin E. Dunlap. Illustrated account of the great destruction of property in Canada and Western New York. 900 w. Eng News—Oct. 13, 1898. No. 23333.

Tunneling.

Shield Tunneling for Sewers in Melbourne. Illustrated description of methods and apparatus used in 7 miles of sewers 5 to 12 feet in diameter. Abstract of paper read before the Victoria Inst. of Engs. by George Henry Dunlop. 6000 w. Eng Rec—Oct. 15, 1898. Serial. 1st part. No. 23357.

Vienna.

Plans of the City of Vienna at the Time of the First Turkish Siege. (Die Wiener Stadtpläne zur Zeit des Ersten Türkenbelagerung.) S. Wellisch. An account of the two maps of the city made by Hirschvogel and Wolmuet from surveys in 1547. The probable errors are determined by comparison with existing landmarks and the old methods described and illustrated. An interesting contribution to the history of surveying. Three articles. 10,000 w. Zeitscr d Oesterr Ing u Arch Ver—Sept. 16, 23, 30, 1898. No. 23518 each B.

Water Rights.

The Ownership of Underground Water. Reviews a decision of the Utah Supreme Court, on the law of underground water. 1200 w. Eng Rec—Oct. 22, 1898. No. 23621.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Brazil.

American Trade with Brazil. Reviews the iron and steel trade with this country, explaining the falling off in the 1897 trade, and giving some information concerning trade opportunities. 1800 w. Am Mfr & Ir Wld—Sept. 30, 1898. No. 23213.

Calcutta.

Trade of Calcutta with the United States, 1897-98. A report compiled from the returns of the collector of customs of the port of Calcutta, of the foreign trade for the official years 1894-1898, showing the trade with the United States. 800 w. Cons Repts—Sept., 1898. No. 23028 D.

Caracas.

The Caracas Warehouse. A description of the institution and its exhibits, which are grouped in the various rooms according to trades, the plan of organization, etc. 4000 w. Cons Repts—Oct., 1898. No. 23030 D.

Caroline Islands.

The Caroline Islands. Extract from a letter written by F. W. Christian, of the Polynesian Society of Wellington, New Zealand, giving an interesting description of the Caroline Archipelago, the customs of the natives, products, &c. 4000 w. Cons Repts—Sept., 1898. No. 23022 D.

China.

New Trade Regulations on the Yangtze. A copy of the revised regulations of trade on the Yangtze river, which will take effect after having received the approval of the foreign representatives at Pekin. 1200 w. Cons Repts—Sept., 1898. No. 23023 D.

Our Policy in China. Mark B. Dunnell. Presents the existing conditions brought about by foreign powers, and discusses what the policy of the United States should be to preserve our present treaty rights of admission to the Chinese market upon terms of equality with other nations. 6000 w. N Am Rev—Oct., 1898. No. 23207 D.

The British Record in China. Alexis Krausse. Reviews the history of the relations between Great Britain and China, and their bearing upon trade. 4800 w. Fortnightly Rev.—Sept., 1898. No. 23117 E.

The Chinese and Recent Industrial Progress in China. J. S. Fearon & E. P. Allen. A discussion of the vast industrial interests awaiting development in China together with an account of the racial and political difficulties to to be overcome. 4000 w. Engineering Magazine—Nov., 1898. No. 23590 B.

The Industrial Situation in China. Considers the alliance with Russia, the Siberian Railway, the struggle for markets, railway progress, and other business aspects. 5000 w. Ir & Coal Trds Rev—Sept. 30, 1898. No. 23280 A.

Coal Trade.

Coal Exports and National Trade. A survey of the position of Great Britain at the present time, the home industries which absorb coal in the production of steam power, the exports, &c. 2300 w. Col Guard—Oct. 14, 1898. No. 23607 A.

The Present Position of the Coal Trade and Some of Its Difficulties. William Armstrong. An address before the North of England Inst. of Min. and Mech. Engs. Reviews the present condition, the difficulties and the line of action by which they might be advantageously met and overcome. 2000 w. Col Guard—Oct. 14, 1898. No. 23606 A.

Commercial Problem.

The Coming Struggle in the Pacific. Benjamin Taylor. An interesting discussion of some of the problems to be solved in the approaching development of the Pacific. The Nicaragua canal, the cable communication, commercial aspects, and various new complications. 8400 w. Nineteenth Cent — Oct., 1898. No. 23-395 D.

Denmark.

Trade with Denmark. Hints on the requirements of the Danish market in iron and steel manufactures and urging the increase of the United States trade. 1800 w. Am Mfr & Ir Wld—Oct. 14, 1898. No. 23438.

Egypt.

Trade Conditions in Egypt. Report on trade conditions, with suggestions as to the export trade from the United States. 6000 w. Cons Repts—Oct., 1898. No. 23029 D.

Engineering.

Empire and Engineering. Editorial discussion of the problems of the present time and the factors that have brought them about, especially the influence of the engineer. 2500 w. Engng—Oct. 14, 1898. No. 23617 A.

Export Markets.

The Quest for Export Markets. Gives information concerning methods of extending trade, the steps taken by Germany and France, and the needs of the United States to enable it to master the science of international commerce. 1700 w. Cons Repts—Oct., 1898. No. 23-031 D.

German Trade.

German Colonial Expansion. Editorial on report by the secretaries of the British Embassy at Berlin, especially the part that deals with the efforts of Germany to gain a foothold in China. 1400 w. Engng—Sept. 23 1898. No. 23146 A.

Harbor Regulations.

Japanese Harbor Regulations for Open Ports. Translation of the new harbor regulations promulgated by imperial ordinance. 2000 w. Cons Repts—Oct., 1898. No. 23033 D.

India.

The Iron and Metal Work in India. Interesting information relating to the advancement of these industries, the articles imported, &c. 1500 w. Ir Age—Sept. 29, 1898. No. 23070.

Lumber.

The Lumber Trade of Belgium. This is one of the most important articles in the Belgian import trade. The valuation of imports from different countries is given, and information valuable to American exporters. 3500 w. Cons Repts—Oct., 1898. No. 23032 D.

Machinery Trade.

The Swiss Machinery Trade in 1897. H. L. G. Reports a very flourishing condition. 600 w. Am Mach—Sept. 29, 1898. No. 23108.

Mexico.

Our Trade with Mexico. Showing the importance to the United States of this market, and giving report of exports. 1200 w. Am Mfr & Ir Wld—Oct. 21, 1898. No. 23644.

New York.

New York's Commerce. A statement prepared by Alex. R. Smith suggesting the scope of the inquiry and the subjects that should be investigated by the New York Commerce Commission to restore commerce. 4000 w. Sea—Oct. 13, 1898. No. 23350.

New Territory.

Commerce with Our New Possessions. E. W. Blatchford. An address delivered before the Illinois Mfrs. Assn. Presents the conditions of the United States in relation to the interests of commerce, and gives the writer's views in regard to the country's duty to the newly acquired islands. 2400 w. Dom Engng —Oct., 1898. No. 23643 C.

Nicaragua Canal.

The Nicaragua Canal. I. The Political Considerations. L. M. Keasbey. II. The Commercial Interests. Emory R. Johnson. Two interesting papers on the questions to be considered in relation to the construction of this canal. 9000 w. Am Rev of Revs—Nov., 1898. No. 23699 C.

Norway.

American Trade with Norway. Explaining the character of the Norwegian market, noting the value, amount and sources of the chief importations. 1600 w. Am Mfr & Ir Wld—Oct. 7, 1898. No. 23311.

Philippines.

Commerce with the Philippines. Statistics relating to the imports and exports compiled from official publications of the various countries mentioned, in the possession of the Bureau of Foreign Commerce. 1500 w. Cons Repts—Sept., 1898. No. 23021 D.

Commercial and Industrial Conditions in the Philippines. Extracts from the *Bulletin de la Société de Geographie Commerciale*, Paris. Discusses the market for European goods, the resources of the islands, &c. 1800 w. Cons Repts—Oct., 1898. No. 23034 D.

Russia.

The Iron Industry and Iron Trade in Russia. (Die Eisenindustrie und der Eisenhandel in Russland.) A statistical paper showing the rapid growth of the Russian iron industry in recent years. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 1, 1898. No. 23574 B.

Shipping.

The Future of Merchant Shipping. Editorial discussion of a paper by Elmer Lawrence Corthell, read before the Am. Assn. for the Adv. of Science, at Boston. 1400 w. Engng—Oct. 14, 1898. No. 23619 A.

South Africa.

Imports into South Africa. Information relating to the trade with Germany, England and the United States and the foothold gained by the last named country. 2200 w. Cons Repts—Sept., 1898. No. 23026 D.

Trade Openings in South Africa. Reports dealing with various lines of imports. Considers cold-storage plants, horses and mules, bicycles, agricultural implements, harness, lumber, coal, groceries and provisions, &c. 5400 w. Cons Repts—Sept., 1898. No. 23027 D.

CURRENCY AND FINANCE.

Sound Money.

Sound Money Misrepresentation. Discusses a monograph by Edward Atkinson which appeared in an issue of the Sound Currency Committee of New York. 2800 w. Gunton's Mag—Oct., 1898. No. 23111 C.

Surplus Revenues.

Surplus Revenues and Future Financial Legislation. Discussing the effect of the money accumulating in the U. S. Treasury as a result of the loan and the war revenues. 2400 w. Banker's Mag, N. Y.—Oct., 1898. No. 23364 D.

LABOR.

Labor Relations.

Relationship Between Employers and Workmen in the Engineering Trades. Benjamin C. Browne. Presidential address before the North-East Coast Inst. of Engs. and Shipbuilders, discussing the question stated. 4400 w. Col Guard—Oct. 14, 1898. No. 23608 A.

Strikes.

Retrospective Lessons on Railway Strikes. Review of work by E. J. O'B. Croker, with extracts. Ill. 1500 w. Transport—Sept. 16, 1898. No. 23047 A.

Wages.

The Evolution of High Wages from Low Cost of Labor. Edward Atkinson. Read before the Am. Assn. for the Adv. of Science. A statement of existing conditions of prices and wages introductory to a discussion of the views of Malthus and their errors, and drawing conclusions bearing on commerce. 5500 w. Ap Pop Sci M—Oct., 1898. No. 23068 D.

Workmen's Compensation.

Workmen's Compensation in Relation to Collieries. Showing the great burden imposed upon colliery proprietors. 1800 w. Col Guard—Sept. 30, 1898. No. 23287 A.

MISCELLANY.

Alaska.

Colonial Lessons of Alaska. David Starr Jordan. Reviews the history of Alaska, indicating lessons to be learned, giving facts relating to the fur, salmon, and other industries. 11,000 w. Atlantic M—Nov., 1898. No. 23679 D.

Ceramic Industry.

Building-Ceramic Industries in England. Translated from the *Thonindustrie Zeitung*. Descriptive account of methods and products. 2200 w. Brick—Oct., 1898. No. 23255.

China.

England's Destiny in China. F. E. Younghusband. Presents the situation in China, discussing the causes, and the steps taken by Russia and other European Powers, stating their present position and what the policy of England should be. 8000 w. Contemporary Rev—Oct., 1898. No. 23366 D.

Disarmament.

Finance and Disarmament. Sydney J. Murray. Discusses the Tzar's proposal, and what would be the effect of general disarmament. Thinks it would involve a dislocation of trade relations, all over the world. 1800 w. Bankers' Mag, Lond—Oct., 1898. No. 23365 D.

Should Europe Disarm? Sidney Low. Discusses the question of militarism and national wealth and related subjects, concluding that the time is not yet ripe for dispensing with the soldier. 4500 w. Nineteenth Cent—Oct., 1898. No. 23394 D.

The Tzar's Appeal for Peace. Presents the writer's view of the situation, and the impossibility of the Tzar's power to enforce his personal wish in this matter. 3500 w. Contemporary Rev—Oct., 1898. No. 23368 D.

Education.

The Overcrowding of the German Technical High Schools. (Die Ueberfüllung der Deutschen Technischen Hochschulen.) An address to the Prussian government by the German Society of Engineers, showing the manner in which the demand for a technical education is crowding the higher educational institutions, and suggesting various remedies. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 17, 1898. No. 23524 D.

The University and the Technical High-School. (Universität und Technische Hochschule.) F. Klein. An address showing the influence of the demand for technical training, and the importance of including a greater proportion of practical science in University instruction. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 24, 1898. No. 23526 D.

Exposition.

The Paris Exposition of 1900, and Its Leading Features. Data relating to the progress thus far in preparation for this great exposition, with illustrations and general plan. 2300 w. Elec Eng, N. Y.—Oct. 27, 1898. No. 23659.

Philippines.

What Shall Be Done About the Philippines? Mayo W. Hazeltine. Thinks the entire Philippine Archipelago should be kept by the United States, but that the signing of the protocol has made it impossible except by purchase. 3300 w. N Am Rev—Oct., 1898. No. 23206 D.

Pittsburg.

The Agricultural, Mineral, Industrial and Commercial Resources of Pittsburg and Vicinity. Thomas Bruce. The wonderful resources of this section are shown and its influence in the fields named. Ill. 22,500 w. Am Mfr & Ir Wld—Oct. 7, 1898. No. 23309.

Transport.

See Railway Affairs, Conducting Transportation.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Batteries.

A Comparison of the Electromotive Force of the Clark and Cadmium Cells. S. N. Taylor. Describes work performed at the Physical Laboratory of Clark University, and also the apparatus used and results obtained. 5700 w. Phys Rev—Sept.-Oct., 1898. No. 23658 D.

Contributions to the Theory and Construction of Galvanic Elements. (Beiträge zur Theorie und Konstruktion Galvanischer Elemente.) Dr. G. Platner. Applications of the modern electrochemical theory to the galvanic battery, including the use of chlorate of sodium as a depolarising material. 1800 w. Elektrochemische Zeitschr—Oct., 1898. No. 23559 H.

How to Make a Dry Cell. A dry cell is merely a non-spilling wet cell. Directions for making are given and some of the particular forms of dry cells considered. 2200 w. Am Elect'n—Oct., 1898. No. 23098.

Notes on the Structure and Management of Leclanche Batteries. J. Warren. An explanation of some points not generally understood, with precautions needed in the care of the batteries. 900 w. Elec, Lond—Oct. 14, 1898. No. 23483 A.

Calcium Carbide.

The Manufacture of Calcium Carbide in Switzerland. Edward A. Schneider. Reports a great advance in the manufacture due to cheap water power, the improved methods and favorable conditions. 700 w. Ind & Ir—Sept. 30, 1898. No. 23284 A.

Chemistry.

The Electric Current in Organic Chemistry. Edgar F. Smith. Address of the Vice President before Section C of the Am. Assn. for the Adv. of Science. A sketch of the progress in the electrolysis of organic bodies. 6000 w. Science—Sept. 30, 1898. No. 23038.

Chromium.

Some Notes on the Electro-Deposition of Chromium. Sherard Cowper-Coles. Gives some of the characteristics, a summary of the results of experiments carried out by Prof. Hittorf, and the investigations of Herr Eschermann, Dr. Hans Goldsmidt, Claude Vautin, and others. 1000 w. Elec Rev, Lond—Sept. 30, 1898. No. 23276 A.

Decomposition.

Studies upon the Voltages of Decomposition. (Studien über Zersetzungsspannungen.) E. Bose. A long and elaborate account of experimental investigations into the voltages at which the electrical decomposition of various compounds occur. Many tables and diagrams are given. 10,000 w. Zeitschr f Elektrochemie—Oct. 6, 1898. No. 23560 H.

Electrodeposition.

See Mining and Metallurgy, Gold and Silver.

Electrolysis.

Electrolysis of Water Pipes at Dayton, O. Extracts from the reports of experts, called to thoroughly investigate the extent of damage, and from the report of the secretary of the Dayton Water Works' Board. 2800 w. Eng News—Oct. 6, 1898. No. 23246.

Furnace.

The Electric Furnace. F. Jarvis Patten. Describes early historical forms, and recent improvements. Ill. 2700 w. Elec Wld—Oct. 22, 1898. No. 23428.

Metal Cleaning.

Electrolysis in the Cleaning of Metallic Surfaces. C. F. Burgess. Discusses methods in use for the removal of foreign substances from metallic surfaces, dealing especially with electrolytic processes, and giving results of investigations. 2800 w. Elec Wld—Oct. 29, 1898. No. 23667.

Nitrogen.

Fixation of Atmospheric Nitrogen. William Bouldin, Jr. Discusses the recent address by Prof. Crookes before the British Assn. and suggests other lines for study of this important subject. 1500 w. Am Gas Lgt Jour—Oct. 3, 1898. No. 23167.

Phosphorus.

The Electro-Thermal Process for the Manufacture of Phosphorus. John B. C. Kershaw. A brief historical review, with description of the electro-thermal method, and reasons why the phosphorus industry is in a very unsettled state. 900 w. Elec Rev, Lond—Oct. 7, 1898. No. 23424 A.

Photochromy.

The Photochromy of Metals. Translated from *La Revue Technique*. Brief account of investigations of the color effects of thin electrically deposited metallic films, by Edmund Becquerel, and Joseph Girard. 1000 w. Eng & Min Jour—Oct. 29, 1898. No. 23701.

Storage Batteries.

See Street and Electric Tramways.

Zinc.

Two Electrolytic Methods of Determining Zinc. (Zwei Elektrolytische Zinkbestimmungen.) Dr. H. Paweck. A review of preceding methods of determining zinc, and an account of the results obtained by modifying the material and character of the anodes. 1800 w. Oesterr Zeitschr f Berg u Huttenwesen—Sept. 17, 1898. No. 23571 B.

LIGHTING.

Arc Lamp.

A Submarine Arc Lamp. Illustrated description of a device which promises to be of value in diving and wrecking operations. 900 w. Elec Rev, N. Y.—Oct. 19, 1898. No. 23419.

Duflos Arc Lamp. A. Z. in *L'Industrie Electrique*. Illustrates and describes an arc lamp in which the regulation is effected by a shunt coil. 800 w. Elec Rev, Lond—Sept. 30, 1898. No. 23274 A.

The Duflos Arc Lamp. (Lamp à Arc Duflos.) A very simple arc lamp mechanism operated by an electro magnet in a derived circuit, without the use of any braking mechanism. 1000 w. Electricien—Oct. 1, 1898. No. 23554 B.

The Electrical Properties of the Vapors from the Carbon Arc. Ernest Merritt and Oscar M. Stewart. Describes experiments undertaken to study in detail the conducting property possessed by the arc vapors, giving results. 4300 w. Phys Rev—Sept.-Oct., 1898. No. 23657 D.

The Sonja Long-Burning Lamp. (Sonja-Dauerbrandlampen.) An illustrated description of an improved enclosed arc lamp of simple construction, having a burning period of from 100 to 200 hours. Elektrotech Zeitschr—Sept. 29, 1898. No. 23550 B.

Circuit-Controller.

Improved Circuit-Controller for Vacuum Tube Lighting and Other Purposes. Details of the invention recently patented by Nikola Tesla, with illustration. 2200 w. Elec Rev, N. Y.—Oct. 19, 1898. No. 23420.

Comparison.

A Comparison of Different Systems of Lighting. From a communication in the Transactions of the *Société Technique du Gaz en France*, by M. Bouvier, giving results of investigations to ascertain the comparative value of different systems of lighting. 700 w. Jour of Gas Lgt—Oct. 11, 1898. No. 23449 A.

Current Price.

Reduction of the Price of Current by the New York Edison Company. A new schedule of prices with comments and editorial. 2200 w. Elec Eng, N. Y.—Oct. 13, 1898. No. 23314.

Decorations.

Electric Lighting in the Chicago Peace Jubilee. An illustrated description of the fine effects wrought by the use of about fifty thousand incandescent lamps. 1800 w. Elec Wld—Oct. 29, 1898. No. 23664.

The Illumination at the Knights Templar Conclave. Illustrates and describes some of the features of the elaborate display at Pittsburg. 1100 w. Elec Wld—Oct. 22, 1898. No. 23427.

Enclosed Arc.

The Photometry of the Enclosed Alternating Arc. Charles P. Matthews, W. H. Thompson, and J. E. Hilbish. Experimental data of the behavior of this type of illuminant. Apparatus used, results, and comments. Ill. 3300 w. Trans Am Inst of Elec Engs—Aug. & Sept., 1898. No. 23489 D.

Filaments.

A New Incandescent Filament for Electric Lights. Information concerning the improved incandescent filament announced by Dr. Auer von Welsbach. 500 w. Cons Repts—Sept., 1898. No. 23024 D.

Incandescent.

Incandescent Lamps as Manufactured by the Shelby Electric Company, Shelby, O. A detailed account of the manufacture of these lamps, noting their principal features. Ill. 3000 w. Elec Eng, N. Y.—Oct. 13, 1898. No. 23315.

Inclosed Arc.

The Photometry of the Inclosed Alternating Arc. Charles P. Matthews, W. H. Thompson and J. E. Hilbish. Paper presented at the New York meeting of the Am. Inst. of Elec. Engs. Discusses the three reasons why the results, in so far as they involve the determination of luminous intensity, are unsatisfactory, giving tests and their results. 2500 w. Elec Wld—Oct. 8, 1898. No. 23242.

Lighthouses.

Electric Lighthouses. Recent improvements in the systems used, with illustrated description of the Penmarch light. 1000 w. W Elect'n—Sept. 24, 1898. No. 23055.

See Civil Engineering, Harbors.

Lighting Contract.

The New Public Lighting Contract in Boston. Editorial review of an agreement making the lighting company merely an agent of the city, subject to arbitration. 1200 w. Eng Rec—Oct. 1, 1898. No. 23153.

Lighting System.

An Experimental Two-Wire 220-Volt Lighting System. Louis E. Foulks. Describes a plant located in New Egypt, N. J., lighting its streets and business buildings. 1300 w. Elec Wld—Oct. 22, 1898. No. 23429.

Potential.

The Drop of Potential at the Carbons of the Electric Arc. Mrs. Ayrton. Abstract of a paper read before the British Assn., Section A. An account of experiments made and results obtained. 1200 w. Elect'n, Lond—Sept. 23, 1898. No. 23124 A.

Ship Lighting.

Electrical Distribution on Board Ship. J. C. Bagot. Notes on methods used and precautions necessary. Ill. 1200 w. Elec Eng, Lond—Oct. 7, 1898. No. 23396 A.

Station Operation.

Methods of Operation and Distribution of an Electric Light Station. John W. Lieb. A lecture to the senior class of the Stevens Inst. Explains the methods employed at the Duane Street station of New York. 1500 w. Stevens Ind—Oct., 1898. No. 23651 D.

Torpedo Vessels.

Electric Light on Torpedo Vessels. B. Pontifex. Discusses the wiring, searchlights, fittings and other arrangements. Ill. 1800 w. Elec Eng, Lond—Oct. 7, 1898. No. 23397 A.

Victoria.

Hawthorn (Victoria) Electric Lighting Scheme. From a report of the Electric Lighting Committee of the city of Hawthorn, Victoria, describing the system. 1500 w. Elec Rev, Lond—Sept. 23, 1898. No. 23129 A.

Welsbach.

Welsbach's Electric Lamp. Discusses the materials of the new filaments and gives Dr. William H. Wahl's opinion. Thinks there is to be no great advancement in electric lighting because of this invention. 1200 w. Jour Gas Lgt—Sept. 20, 1898. No. 23100 A.

Wiring.

Interior Electric Wiring. H. N. Gardner. An article for the benefit of beginners but containing suggestions for even competent wiremen. 2700 w. W Elect'n—Oct. 8, 1898. No. 23258.

Wiring the New York State Capitol. Describes what is claimed to be the largest and most difficult contract for concealed work in a finished building ever executed in the United States. Ill. 1400 w. Elec Eng, N. Y.—Oct. 13, 1898. No. 23313.

POWER.

Alternators.

The Paralleling of Alternators. Edward P. Burch. Gives suggestions of two simple ways of connecting alternators in parallel. 700 w. Elec Wld—Oct. 8, 1898. No. 23243.

Central Station.

The Evolution in Central Station Practice. Charles F. Scott. Showing the development of the polyphase system, and its especial adaptability for the distribution of power from central stations; including numerous illustrations and diagrams. 3500 w. Engineering Magazine—Nov., 1898. No. 23598 B.

Core Distribution.

Air-Gap and Core Distribution. W. Elwell Goldsborough. This first paper deals with the magnetic flux and its effect upon the regulation and efficiency of dynamo electric machinery. Outlines a method of calculating field densities which has been used by the writer with success. 3200 w. Trans Am Inst of Elec Engs—Aug. and Sept., 1898. Serial. 1st part. No. 23491 D.

Electric Boring.

A New Application of the Electric Arc. J. Foster Symes. Describes a method of boring the rivet holes in armor plates, welding, and other uses. 1200 w. Yale Sci M—Oct., 1898. No. 23708 C.

Electric Energy.

Electric Energy in Bulk. An editorial on the proposed changes in electric light and power stations in England and the economy sought. 2200 w. Engng—Oct. 7, 1898. No. 23415 A.

Electric Power.

Electric Current for Lighting and Power on the Midland Railway, and Driving Machinery Direct by Electric Motor without Shafting. W. E. Langdon. Paper read before the Institution of Mech. Engs., England. Detailed description of the installations, with output and costs. 3000 w. Elect'n, Lond—Sept. 30, 1898. No. 23271 A.

Electric Light and Power at the Hofors Ironworks, Sweden. Illustrated description of the plant. 1400 w. Elec Eng, Lond—Sept. 30, 1898. No. 23272 A.

Gasoline Plant.

Gasoline Pumping and Lighting Plant at La Fox, Ill. A plant installed by the C. & N. W. Ry. for supplying water for the tanks and lighting buildings and yard. Ill. 900 w. Ry & Engng Rev—Oct. 15, 1898. No. 23434.

Haulage.

Electric Canal Haulage. A. H. Allen. Read before the British Assn., at Bristol. Describes an adaptation of electrical traction to canal haulage, invented by Messrs. Thwait and Cawley. It can be applied without interfering with the use of horses. The barges are hauled by means of rope, and an aerial railway is provided for the motors. Ill. 2500 w. Elec Eng, Lond—Sept. 30, 1898. No. 23273 A.

Hydraulic Plant.

The Hydraulic Electric Plant on the Sihl, Switzerland. (Station Hydro Electrique de la Sihl, Suisse.) A description of the hydraulic plant recently completed, by which about 2000 h. p. of the Sihl above Zurich are utilized for lighting and power. A fall of over 200 feet is obtained by running a channel across a loop formed by the river. Details of the turbines and generators are given. 3000 w. 1 plate. Le Génie Civil—Oct. 8, 1898. No. 23506 D.

Isolated Plant.

Power Plant of the Chicago Public Library. Brief description, giving the boiler tests and engine tests. Ill. 2000 w. Engr, N. Y.—Oct. 15, 1898. No. 23444.

Lifts.

Electric Dumb Waiters in the Chicago Public Library. Illustrates and describes the arrangements for delivering books from one department to another in the building. 2000 w. Elec Eng, N. Y.—Oct. 6, 1898. No. 23229.

Tests of Electric Elevators. William S. Monroe. Gives data concerning the power used in starting and moving. 800 w. Eng Rec—Oct. 1, 1898. No. 23159.

The Fraser Electric Elevator. A. E. Brooke Ridley. Briefly reviews various elevator systems, pointing out the disadvantages of each, and gives a somewhat detailed description of the invention of E. M. Fraser, which it claims, obviates most of the disadvantages mentioned. Also discussion. 8800 w. Jour Assn of Engng Soc's—Sept., 1898. No. 23706 C.

Power Station.

Colorado Electric Power Co.'s Station at Cañon City. Bert E. Wade. Illustrated detailed description of a plant designed to supply power and light to mines. 1200 w. Elec Eng, N. Y.—Oct. 20, 1898. No. 23440.

Test of the LaFayette, Ind., Street Railway Power Plant. G. W. Munro. Abstract of a thesis presented to the Faculty of Purdue Univ. Describes the plant and the conditions of schedule and grade, reporting the tests and results. Ill. 2000 w. St Ry Rev—Oct. 15, 1898. No. 23455 C.

The Generation of Electricity by Water Power at Mechanicsville, New York. An illustrated detailed description of a Hudson River power-plant which will supply Schenectady and other places in the vicinity. 3200 w. Power—Oct., 1898. No. 23228.

Regulation.

The Regulation of the Mechanical Plant. Brief description of this system for automatically regulating the voltage of power delivered.

An interesting application of various principles of alternate-current working. 1200 w. Elec Wld—Oct. 1, 1898. No. 23088.

Storage Batteries.

Electricity in Packages. E. Ralph Estep. Deals with the rapid development of the storage battery and the uses to which it is applied. Ill. 3500 w. Mod Mach—Oct., 1898. Serial. 1st part. No. 23435.

Tanning.

Tanning by Electricity. Describes and illustrates an important device of a Boston inventor which gives promise of causing great changes in this business. 1600 w. Bos Jour of Com—Oct. 22, 1898. No. 23480.

Transmission.

A French View of Electrical Power Transmission. Abstract of an interesting article in the *Revue Générale des Sciences*, by M. Paul Janet. Discusses the efficiency of transmission, and the systems employed. 2000 w. Elec Rev, Lond—Sept. 30, 1898. No. 23275 A.

On the Transmission of Power by Two- and Three-Phase Currents. Andrew Stewart. Considers the merits of the two systems. 1200 w. Elec, Lond—Oct. 14, 1898. No. 23482 A.

Tesla's System of Electric Power Transmission Through Natural Media. Illustrates and describes a novel method for the transmission of electrical energy without metallic line conductors. 2000 w. Elec Rev, N. Y.—Oct. 26, 1898. No. 23663.

The Transmission Plant of the Fries Manufacturing and Power Company. An illustrated description of a North Carolina plant. 2200 w. Am Elect'n—Oct., 1898. No. 23095.

Water Wheels.

Electric Transmission in California. Alfred Tregidgo. Illustrates and describes the Tutthill impulse water-wheels in course of erection at the San Gabriel Electric Co.'s Power Station, Azusa, Cal. 400 w. Min & Sci Pr—Oct. 15, 1898. No. 23470.

Wave Power.

The Utilization of Wave-Power. On the investigations of B. Morley Fletcher, with illustrated account of a successful visit recently paid to Spanish waters to demonstrate further the value of his invention. Ill. 1800 w. Ind & Ir—Sept. 30, 1898. No. 23283 A.

TELEGRAPHY AND TELEPHONY.

Balloon Signalling.

The Use of Electric Balloon Signalling in Arctic and Antarctic Expeditions. Eric Bruce. Read before the British Assn. Describes a system invented by the author and adapted for war signalling purposes, and lately adapted to the wants of exploration. 800 w. Elec Eng, N. Y.—Oct. 20, 1898. No. 23442.

Cable Routes.

Side Lights on Cable Routes. Part first discusses proposals made by the Eastern, Eastern Extension, and Eastern and South African telegraph companies, to the Imperial Government. 2000 w. Elec Rev, Lond—Sept. 23, 1898. Serial. 1st part. No. 23128 A.

Disturbances.

Some Telephone Disturbances from Electrical Generators. George D. Shepardson. Reports a study of troubles in a western city, describing experiments made and conclusions reached. 6400 w. Trans Am Inst of Elec Engs—Aug. & Sept., 1898. No. 23490 D.

Exchange.

The New Telephone Exchange at Worcester, Mass. Describes a building built expressly for this purpose and equipped with the latest and most approved appliances. Ill. 1000 w. Elec Eng, N. Y.—Oct. 13, 1898. No. 23317.

Limiting Distance.

Limiting Distance of Telephone Speech and the K. R. Law. A. E. Dobbs. Discusses some points affecting the capacity of a line, showing that the limiting distance has not yet been found. 1600 w. Elec Eng, N. Y.—Oct. 27, 1898. No. 23660.

Pacific Cable.

An All-British, or Anglo-American, Pacific Cable. Charles Bright. Discusses the question of spanning the Pacific ocean, connecting with the British colonies, giving reasons in favor of All British lines, and also considering an alliance with the United States. Map. 3000 w. Fortnightly Rev—Sept., 1898. No. 23118 E.

On the Pacific Cable. Charles Bright. Read before the British Assn. for the Adv. of Science. A discussion of the main features of interest and importance, including the survey, type of cable, laying, repairing, electrical working. 4000 w. Elec Rev, Lond—Sept. 23, 1898. No. 23130 A.

Persia.

Telegraphs and Telephones in Persia. An account of the construction, systems in use, and progress. 800 w. Jour Soc of Arts—Oct. 14, 1898. No. 23484 A.

Space Telegraphy.

The Hertzian Telegraphy Without Wires. (La Télégraphie Hertzienne, sans Fil.) E. Ducretet. Containing numerous illustrations of the apparatus used in space telegraphy, and a general description of the method; being an address before the International Society of Electricians. Two articles. 2500 w. Electricien—Oct. 8, 15, 1898. No. 23556 each B.

Telegraphy by Means of Ultra-Violet Light. Karl Zickler. Abstract of an article in the *Elektrotechnische Zeitschrift*. Describes apparatus used, experiments made and gives results obtained. 1800 w. Elect'n, Lond—Sept. 23, 1898. No. 23125 A.

Wireless Telegraph and Signal Co. (Limited). A report of the second general meeting with an interesting speech by H. J. Davis, chairman and managing director. Also editorial. 4500 w. Elect'n, Lond—Oct. 14, 1898. No. 23604 A.

Telephones.

The State and the Telephones; the Story of a Betrayal of Public Interests. Robert Donald. Discusses matters brought to light by investigations of a select committee of the British House of Commons, and the solution of the difficulties. 7500 w. Contemporary Rev—Oct., 1898. No. 23370 D.

MISCELLANY.

Accumulators.

A Comparison Between Various Accumulators. (Ueber die Vergleichende Darstellung von Akkumulatoren.) P. Schoop & H. Benndorf. A detailed account of comparative tests. Very fully tabulated data are given, this instalment containing the results for the Baumgarten and the Gülcher accumulators. Serial. Part 1. Elektrochemische Zeitschr—Oct., 1898. No. 23558 H.

The Action of Accumulators. (Die Wirkungsweise der Akkumulatoren.) Dr. F. Hoppe. A discussion of the chemical and physical actions involved in the operation of the electrical storage battery. 2000 w. Elektrotech Rundschau—Oct. 15, 1898. No. 23545 B.

Alternating Currents.

Alternating Currents. The first of a series of articles dealing with the phenomena, principles, and application of these currents. Ill. 3800 w. Ind & Ir—Sept. 30, 1898. Serial. 1st part. No. 23282 A.

A New Form of Alternating Current Instrument. Arthur C. Heap. Describes a method of construction designed by the writer to overcome sources of error in amperemeters and voltmeters. Ill. 800 w. Elec Rev, Lond—Sept. 23, 1898. No. 23127 A.

Ampere.

Redetermination of the Ampere. Report of the committee on Standards of Measurement to the Am. Assn. for the Adv. of Science. 700 w. Elec Rev, N. Y.—Oct. 5, 1898. No. 23119.

Capacity.

Electrostatic Capacity of Wires. W. Moon. Mathematical demonstration. 800 w. Elec Rev, Lond—Sept. 30, 1898. No. 23277 A.

Commutators.

Devices for Exploring the Potential Around Commutators. George D. Shepardson. Describes methods and simple devices for various investigations. 1600 w. Am Elect'n—Oct., 1898. No. 23096.

Conduits.

Two Draw-In Conduits Under Boston Rivers. Illustrated detailed description. 1300 w. Elec Wld—Oct. 29, 1898. No. 23665.

Currents.

Currents in Branched and in Mutually Inducing Circuits Produced by Harmonically Varying Electromotive Forces. Thomas R. Lyle. The first of a series of articles in which the writer aims to reduce the currents named to something of the simplicity of the theory of steady currents in branched conductors. 1500 w. Elect'n, Lond—Oct. 14, 1898. Serial. 1st part. No. 23605 A.

Duality.

The Duality between Electrical and Magnetic Phenomena. (Die Dualität zwischen Elektrischen und Magnetischen Erscheinung.) W. Weiler. A geometric discussion showing the accordance of electrical and magnetic phenomena with the deductions of the modern geometry of position. 2000 w. Elektrotech Rundschau—Oct. 1, 1898. No. 23544 B.

Earth Currents.

Short Method of Correcting Schaefer's Break Test for Earth Currents. Walter J. Murphy. Rules enabling observers to calculate rapidly, or estimate mentally, the influence of the E. C. upon results obtained by Schaefer's method of localizing breaks in submarine cables. 500 w. Elect'n, Lond—Sept. 23, 1898. No. 23122 A.

High Temperatures.

The Chemistry of High Temperatures. An outline of the researches of M. Henri Moissan for which he has been awarded a Franklin Institute medal. 1200 w. Bos Jour of Com—Oct. 8, 1898. No. 23253.

Hysteresis.

Magnetic Hysteresis and Eddy Currents. (Magnetische Hysteresis und Wirbelströme.) F. Niethammer. A discussion of the methods of determining the magnetic coefficients for various kinds of magnetization; with curves plotted from the results. Two articles. 6000 w. Elektrotech Zeitschr—Oct. 6, 13, 1898. No. 23552 each B.

Jacques Process.

The Jacques Process for Converting Heat into Electricity. Abstract of a paper read by Prof. Langley before the Electric Club of Cleveland. Shows that Dr. Jacques' electric generator is an ordinary thermo-electric battery. Ill. 1700 w. Eng News—Sept. 29, 1898. No. 23074.

Magnetism.

Magnetism. Forée Bain. Suggestions gained by practical observation. 1800 w. W Elect'n—Oct. 8, 1898. No. 23259.

Measurements.

Methods of Using a Wattmeter, a Voltmeter, and an Ammeter. Frederick Bedell. Gives four methods for connecting and reading the instruments. 1200 w. Sib Jour of Engng—Oct., 1898. No. 23473 C.

Simple Volt-, Ampere-, and Wattmeters. Charles T. Child. Illustrates and describes several forms of such instruments that can be easily made by the amateur, at small cost. 2500 w. Am Elect'n—Oct., 1898. Serial. 1st part. No. 23097.

The Construction and Use of Simple Electrical Measuring Apparatus. Howard B. Little. Describes instruments that may be made by electricians with which they can undertake research work. Part first describes the tangent galvanometer. 1800 w. Elec, Lond—Sept. 30, 1898. Serial. 1st part. No. 23262 A.

The Measurement of High Electric Voltages. (Ueber die Messung Hoher Elektrischer Spannungen.) W. Peukert. A method of measuring high voltages by means of condensers in a portion of the circuit, instead of measuring the potential at the terminals. 2000 w. Elektrotech Zeitschr—Sept. 29, 1898. No. 23548 B.

See Street and Electric Tramways.

Plants.

The Action of Electricity on Plants. E. H. Cook. Abstract of a paper read before the

British Assn. Deals with its influence on seed germination, growing plants, &c. 2000 w. Elect'n, Lond—Oct. 7, 1898. No. 23422 A.

Radiography.

Progress in the Technics of Röntgen Rays. (Fortschritte der Röntgentechnik.) Max Levy. A discussion of the theory of the production of Röntgen rays, and a description of the best apparatus for the purpose. 4000 w. Elektrotech Zeitschr—Sept. 22, 1898. No. 23547 B.

Speculations Concerning Roentgen Rays. Francke L. Woodward. A brief statement of things noticed during the writer's researches, with suggestion of a possible explanation. 900 w. Elec Eng, N. Y.—Oct. 13, 1898. No. 23318.

X-Ray Work in Baltimore. C. B. Fairchild. Reports the work in Loyola College, University Hospital and Johns Hopkins Hospital. 2000 w. Elec Eng, N. Y.—Oct. 6, 1898. No. 23231.

Refrigeration.

Electrical Refrigeration. Thomas J. Fay. Describes a system where electricity is used as a motive power, and a compressor, driven by an electric motor, compresses a refrigerating medium. Ill. 1500 w. Elec Eng, N. Y.—Oct. 6, 1898. No. 23230.

Screens.

Applications of Electro-Magnetic Screens. (Applications des Ecrans Electromagnetiques.) A discussion of the effects of screens of magnetic metals in various applications, showing the agreement of practical results with those indicated by theory. Two articles. 2500 w. Electricien—Oct. 8, 15, 1898. No. 23557 each B.

Temperature Coefficients.

On the Determination of the Temperature Coefficients of Two 10-Ohm Standard Resistance Coils (Nos. 3,873 and 3,874) Used in the 1897 Determination of the Ohm. M. Solomon. Read before the British Assn. The results of tests made on the two 10-ohm coils to make as accurate a determination as possible of the values for the coefficients. Ill. 2000 w. Elect'n, Lond—Sept. 23, 1898. No. 23123 A.

Transformers.

Transformer Regulation. Frederick Bedell. An explanation of a simple working formula for determining the regulation drop in lighting and power transformers. 900 w. Elec Wld—Oct. 8, 1898. No. 23241.

Zeeman Effect.

Preston's Investigations on the Zeeman Effect. Study of the effect on the bright lines of the spectrum when placed in a strong magnetic field. 1400 w. Elec Rev, Lond—Oct. 7, 1898. Serial. 1st part. No. 23423 A.

MARINE ENGINEERING.

American Steamers.

American Paddle-Wheel Steamers with Beam Engines. Particulars and description of the engines and steamers used so extensively for inland navigation in the United States. 2500 w. Engr, Lond—Sept. 23, 1898. Serial. 2 parts. No. 23141 each A.

Buoys.

Electric Gong Buoys—Audible versus Visual Signals. F. A. Hamilton. Read at convention of the Maritime Electrical Assn. Illustrated description of a system for utilizing electricity for facilitating navigation, explaining the details of the proposed method. 2400 w. Can Elec News—Oct., 1898. No 23307.

Gondola.

The Gondola: Its History and Manufacture. Condensed from an account by Horatio F. Brown. Interesting information relating to the changes, use and making of these boats of Venice. 1800 w. Sci Am—Oct. 15, 1898. No. 23345.

Ocean Liners.

The Latest Union Liner. Descriptive and illustrated account of the latest addition to the Union Steamship Company's fleet, the twin-screw R. M. S. Briton. 1200 w. Transport—Sept. 30, 1898. No. 23269 A.

Pilot Boats.

The Pilots and Pilot Boats of New York. Gives the history of this service and outlines the changes that have added to the comfort and lessened the peril of the pilot's life. Ill. 1800 w. Sci Am—Oct. 22, 1898. No. 23464.

Propeller.

The Screw Propeller, with Some Notes on the Geometry of the Subject. Part first gives definitions of terms used and refers to the conditions that determine the dimensions and performance generally. 2000 w. Prac Eng—Oct. 7, 1898. Serial. 1st part. No. 23421 A.

Propulsion.

Discussion of Some Theories of Steamship Propulsion. Robert Mansel. Discusses the theories of M. Dupuy de Lome, Rankine and others, showing discrepancies. 2700 w. Engr, Lond—Oct. 14. 1898. No. 23610 A.

The Turbine for Naval Propulsion. Discusses the great speed that has been attained, the probability of the turbine soon replacing the steam engine for marine propulsion, and the defects to be overcome before it can be used on shore. 800 w. Bos Jour of Com—Oct. 22, 1898. No. 23481.

Revenue Cutter.

Machinery for the New Revenue Cutter to be Stationed at New York. Illustrations showing the designs of the engines and boilers of the boat known officially as No. 6, now being built at Baltimore. 700 w. Marine Engng—Oct., 1898. No. 23191 C.

Roller Boat.

Construction and Details of the Knapp Roller Boat. Illustrates and describes the boat, and discusses its operation. 900 w. Sci Am—Oct. 8, 1898. No. 23235.

Shipbuilding.

The Steel Foundations of the Shipbuilding Industry. A review of the transformations which have taken place in the use of steel as a marine structural material, with especial reference to the use of ferro-manganese. 2500 w. Engineering Magazine—Nov., 1898. No. 23-591 B.

Ship Lighting.

See Electrical Engineering, Lighting.

Shipping.

See Economics and Industry, Commerce.

Steamers.

The Latest Additions to the Castle Line to the Cape. Illustrated description of two steamers to be used on the route between England and South Africa. 2500 w. Steamship—Oct., 1898. No. 23193 A.

Submarine Boats.

Submarine Boats. George N. Crouse. Reviews the history of the attempts at submarine navigation, and the degree of success recently attained. 3000 w. Yale Sci M—Oct., 1898. No. 23709 C.

Yacht.

U. S. S. Sylph, Selected by the Navy Department as the President's Yacht. Illustrated detailed description. 1200 w. Marine Engng—Oct., 1898. No. 23189 C.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boiler Plant.

See Mining and Metallurgy, Coal and Coke.

Boiler Plates.

On the Thermal Condition of Iron, Steel and Copper When Acting on Boiler Plates. Ella Mary Bryant. Illustrates and describes investigations made to determine the temperature of boiler plates. The measurements were made by thermo-electric junctions embedded in the substance of the plate. 900 w. Prac Eng—Sept. 23, 1898. Serial. 1st part. No. 23217 A.

Boiler Selection.

The Choice of a Boiler. Discusses some of the points of first importance to be considered. 1700 w. Engng Mech—Oct., 1898. No. 23-662 C.

Boiler Specifications.

Report of Committee on Uniform American Boiler Specifications. The report as finally adopted at the convention of American Boiler Manufacturers Assn. at St. Louis. 4500 w. Ir Age—Oct. 13, 1898. No. 23322.

Boiler Waters.

A Scheme for the Rapid Analysis of Boiler Waters for Scale-forming Ingredients. Thomas B. Stillman. Gives a scheme of analysis used by the author which shows many advantages for correct determinations with rapidity. 600 w. Stevens Ind—Oct., 1898. No. 23647 D.

Cleaning.

Cleaning Boilers. A device, patented by John Stephenson, of Newark, N. J., which permits automatically cleaning the top surface of all tubes. 450 w. Bos Jour of Com—Oct. 1, 1898. No. 23152.

Coverings.

Coverings for Locomotive Boilers. Editorial report of tests being conducted by Charles L. Norton, at the Mass. Inst. of Technology, with statement of facts from reports of tests previously made. 1600 w. R R Gaz—Sept. 30, 1898. No. 23082.

The Protection of Steam-Heated Surfaces. Charles L. Norton. A partial report of investigations still in progress, with illustrated description of method of testing, apparatus used, &c. The relative efficiency of different coverings, the fire risks in certain methods and materials, and the gain in economy are studied. 4000 w. Tech Quar—Sept., 1898. No. 23-201 F.

Evaporation.

The Evaporation of Steam in Boilers. A comparison with nature's process in the evaporation of the dew. 1800 w. Bos Jour of Com—Sept. 24, 1898. No. 23046.

The Relation of Rate of Evaporation to Efficiency of Steam Boilers. George R. Bale. Showing that boilers of all types give practically identical efficiency at any given rate of evaporation, when worked under conditions most suitable to the particular description of the fuel employed. 2500 w. Prac Eng—Sept. 23, 1898. No. 23218 A.

Explosions.

The Boiler Explosions in Germany in the Year 1897. (Die Dampfkesselexplosionen in Deutschen Reiche im Jahre 1897.) A tabulated report with notes giving the ascertainable facts and details of the boiler explosions in the German empire for 1897, with notes and comments. Two articles. 7000 w. Zeitschr d Ver Deutscher Ing—Sept. 24, 1898. No. 23527 each D.

Flues.

Strength of Internal Flues. From the Annual Report of the Engine Boiler and Employers-Liability Insurance Company, Limited (England). Describes experiments on a Lancashire boiler, giving inferences drawn. 700 w. Mech Wld—Sept. 16, 1898. No. 23042 A.

Incrustation.

The Prevention and Removal of Boiler Scale. (Verhinderung und Beseitigung des Kesselsteines.) R. Danilof. A discussion of the various chemical and mechanical methods of preventing and removing incrustations, calling especial attention to the use of cold water for loosening scale. 2000 w. Oesterr Zeitschr f Berg u Huttenwesen—Sept. 24, 1898. No. 23-573 B.

Mining Boilers.

Steam Boilers for Mining Purposes. William

Kent. The principles governing their economical and efficient use. The influence of local conditions on the size and type of boilers, and an impartial study of best types for varying conditions. 1500 w. Mines & Min—Oct., 1898. No. 23175 C.

Oil Filters.

The Removal of Oil from Feed Water. Editorial statement of the value of oil filters for condensing engine plants or systems where exhaust-steam heating is practiced. 900 w. Eng Rec—Oct. 29, 1898. No. 23692.

Smoke Prevention.

Coal Combustion and Smoke Prevention. John L. Howard. Read before the sixth annual meeting of the Pacific Coast Gas Assn., San Francisco. Considers the character and composition of fuels and the conditions that favor complete combustion. 2600 w. Jour of Elec—Sept., 1898. No. 23638.

Smoke Prevention. W. H. Booth. States the conditions causing smoke and the means of controlling the difficulty. 1800 w. Am Mach—Sept. 29, 1898. No. 23107.

The Orvis Smoke Prevention Apparatus. (Appareil Fumivore Orvis.) An illustrated account of one of the furnaces which received honorable mention at the recent tests in Paris. Steam jets are used to deliver air blasts above the grate. 1200 w. Electricien—Sept. 24, 1898. No. 23553 B.

Test Meters.

Test Meters for Boiler Plants. Lehman B. Hoit. Showing the value of the Worthington Test Meter. Ill. and discussion. 3300 w. Jour Assn of Engng Soc's—Sept., 1898. No. 23707 C.

Tubes.

The Grooving of Tube Ends. The cause of this tube-destruction, method of repairing and cure. Ill. 1800 w. Locomotive—Sept., 1898. No. 23632.

Water-Tubes.

Water-Tube Boilers for Utilizing Blast Furnace Gas and Waste Heat. J. H. Ashby. Abstract of paper read at meeting of Cleveland Inst. of Engs., England. The advantages of the Babcock and Wilcox boiler are stated, the arrangement, reheating, &c., are considered. 1800 w. Col Guard—Oct. 7, 1898. No. 23409 A.

COMPRESSED AIR.

Air-Compressing Plant.

Test of a Modern Air-Compressing Plant at the Long Tunnel Gold Mine, Walhalla. E. J. Rigby. Gives results of a test for economy and efficiency, and shows that large savings may be effected by a proper use of the air after compression. Ill. 4400 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23392 G.

Air Lifts.

The Air Lift. Translation of paper by E. Josse, in the *Zeitschrift des Vereines Deutscher Ingenieure*. Gives description of several German plants and the results of tests made on them. 3000 w. Eng Rec—Oct. 8 and 15, 1898. Serial, 2 parts. No. 23183.

Compressor.

A Gasoline Air Compressor for Bridge Work. Illustrates and describes a portable plant for generating compressed air, used in connection with work at West Point, Ky., in strengthening a bridge on the Illinois Central railroad. 1100 w. Ry Age—Oct. 14, 1898. No. 23437.

Efficiency.

What is the Efficiency of an Air Compressor? Frank Richards. A discussion of the subject of compression, showing the fallacy of some ideas generally held. 1400 w. Am Mach—Oct. 6, 1898. No. 23265.

Pneumatic Tools.

A Pneumatic Car Journal Turner. Illustrates and describes a machine that enables car journals to be turned on the repair tracks. 400 w. R R Gaz—Oct. 14, 1898. No. 23343.

Boyer's Pneumatic Drill. Illustrated description of a light, easily handled machine, very powerful for its size, and not liable to get out of order. 4000 w. Engng—Sept. 23, 1898. No. 23145 A.

Tamping.

See Railway Affairs, Permanent Way.

ENGINES AND MOTORS.

Balancing.

The Balancing of Multiple-Cylinder Marine Engines. (Ausbalanzirung Mehrcylindriger Schiffskraftmaschinen.) The full text of the judicial opinion of the Imperial Court upon the limitations of the Schlick system of balancing engines and reducing vibration, in the case of the Vulcan works against Schichau. An interesting and important review of the work of Taylor, Yarrow, Schlick and others. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 17, 1898. No. 23522 D.

Compression.

Cushion vs. Compression. W. H. Wakeman. A brief review of the meaning of the terms is given, pointing out the way to tell the difference on an indicator diagram, and discussion of the subject. 2500 w. Engr, U. S. A.—Oct. 1, 1898. No. 23198.

Condensation.

The Law of Condensation of Steam. Illustrated review of Callender and Nicolson's experiments and their results. 2000 w. Eng Rec—Oct. 22, 1898. No. 23628.

Cooling Reservoirs.

Cooling Reservoirs for Condensing Engines. Harold Wood Barker. From Excerpt Minutes of *Proceedings of the Institution of Civil Engineers*. Illustrates and describes the methods of construction usually adopted when means of storing and cooling are necessary, and considers the size necessary for any given power. 2300 w. Prac Eng—Sept. 23, 1898. Serial. 1st part. No. 23119 A.

Diesel Motor.

Diesel's Rational Heat Motor. E. D. Meier. Introductory review of progress leading to this

latest development in engine construction, with an account of the inventor and his work, a description of the invention and its operation. Ill. 8800 w. Jour Fr Inst—Oct., 1898. No. 23202 D.

Gas Engines.

Gas Producers and the Future of the Gas Engine. A. Bement, in *Modern Machinery*. Discusses the methods being tried in Europe for utilizing blast-furnace gases, the use of water gas, &c. 2300 w. Pro Age—Oct. 1, 1898. No. 23109.

Oil and Gas Engines. James D. Roots. States the lines on which he considers future improvements will be made, and gives an account of experiments and conclusions drawn. 8800 w. Engng Mech—Sept., 1898. No. 23050 C.

The Benier Gas Engine and Producer. Describes an engine and generator which have been proved to do their work satisfactorily. Ill. 1700 w. Engng—Sept. 23, 1898. No. 23144 A.

The Kelly-Kelch Gas Engine. Illustrated description of what is claimed to be something new in this line. 700 w. Am Mfr & Ir Wld—Oct. 7, 1898. No. 23310.

The Thermal Cycle of the Gas Engine. (Die Kreisprozesse der Gasmaschine.) A. Stodola. A very full thermodynamic study of the action of the gas engine, including the Diesel motor, showing the practical application of the entropy diagram. An important paper. Two articles. 10,000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Sept. 17, 24, 1898. No. 23521 each D.

See Municipal Engineering, Water Supply.

Gasoline Motor.

Improved Gasoline Motor. (Nouveau Moteur à Essence de Pétrole.) An illustrated description of the Bidaud motor, well adapted for use on automobiles. 1000 w. Le Génie Civil—Oct. 1, 1898. No. 23505 D.

Motive-Power Machines.

Engines and Pumps for Water, Sewage, and Irrigation Works. Philip R. Bjorling. Part first consists of introductory remarks and commences the description of suitable plants of each class for countries like India and the East. 1600 w. Ind & East Engr—Sept., 1898. Serial. 1st part. No. 23407 D.

Packing.

Packings for Pistons and Valves. (Garnitures de Pistons et de Tiroirs.) M. Haas. Discussing especially piston packings for marine engines operating with high-pressure steam, with many illustrations of actual packings. 3500 w. Revue de Mechanique—Sept., 1898. No. 23537 H.

Pumping Engine.

The Hydraulic Service Engine of the Pope Tube Company. Illustrates and describes a crank machine operating under pressure of 1200 pounds and over per square inch, and running with complete absence of shock at sixty turns per minute. 1000 w. Am Mach—Oct. 20, 1898 Serial. 1st part. No. 23445.

The Kley Steam Pumping Engine for Mine Drainage. (Die Kley'sche Wasserhaltungs-Dampfmaschinenanlage.) Carl Habermann. A description of the compound mining pump used at the Idria Mines, with details of construction and data and results of test. Three articles. 12,000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—Sept. 23, 30, Oct. 7, 1898. No. 23519 each B.

Reversing Engine.

Tandem Reversing Engine. (Tandem Reversirmaschine.) C. Kiesselbach. Describing and illustrating a double tandem compound reversing rolling mill engine constructed for the Hernádthaler Iron Works, Krompach, Hungary. 1500 w. 1 plate. Stahl und Eisen—Sept. 15, 1898. No. 23561 D.

Steam Engineers.

Should a Steam Engineer Be a Machinist? H. H. Kelley. A discussion of this question with the writer's views. 2000 w. Engr, N. Y. Sept. 15, 1898. No. 23061.

Steam Turbine.

The Influence of the Motion of a Ship upon the Flexible Shaft of the de Laval Steam Turbine. (Die Beanspruchung der Federn Ochse der de Lavalschen Dampfturbine in folge von Schwankungen bei Aufstellung in Schiffen.) A. Böttcher. Showing the effect of gyroscopic action, and demonstrating that the effect of the ship's motion is but slight. 2000 w. Zeitschr d Ver Deutscher Ing—Oct. 8, 1898. No. 23532 D.

Willans Engine.

The Willans Central Valve Engine. Illustrates and describes this high-speed engine, with report of tests. 2200 w. Eng & Min Jour—Oct. 1, 1898. No. 23101.

POWER AND TRANSMISSION.

Exposition.

The Universal Exposition of 1900. (Exposition Universelle de 1900.) The official specifications for the steam and electrical power plant, including the concessions to exhibitors for furnishing power. 4500 w. La Revue Technique—Sept. 25, 1898. No. 23511 D.

Installation.

Essential Principles of Economy in Steam Power Installation. W. Cooper. Showing economy of a well designed steam plant as compared with one which has been installed without due system and judgment. 4000 w. Engineering Magazine—Nov., 1898. No. 23593 B.

Power Gage.

A Direct-Reading Power Gage for Steam Engines. Illustrates and describes an invention of G. F. Atwood, which is a radical departure, employing an entirely new principle for the measurement of the pressure in the cylinder. 1200 w. Eng News—Oct. 20, 1898. No. 23460.

Power Plants.

Power Plant Arithmetic. W. H. Wakeman. The first of a series of articles aiming to give needed enlightenment to the men who operate power plants. 1800 w. Engr, U. S. A., Sept. 15, 1898. Serial. 1st part. No. 23062.

Rope Driving.

Ropes and Rope Driving. L. H. Kenyon.

Read before the Manchester Assn. of Engs. Brief review of the history of rope driving with discussion of methods and the means of securing the best results. 1500 w. Can Eng—Oct., 1898. Serial. 1st part. No. 23303.

Water Wheels.

Graphics of Water Wheels. William Fox. Showing the superiority of the graphical method to the analytical in the discussion of the involved problem of turbines and other water-wheels. 2500 w. Stevens Ind—Oct., 1898. No. 23650 D.

SHOP AND FOUNDRY.

Annealing.

Annealing and Casehardening. Joseph Horner. The first of a series of articles giving an account of the processes, furnaces, &c., employed in the work of annealing cast iron and of case-hardening malleable iron. Ill. 1800 w. Mech Wld—Oct. 14, 1898. Serial. 1st part. No. 23498 A.

Ball Bearing.

A Ball Bearing Experience. C. P. Benns. Describes an arrangement including balls which cannot possibly roll, and investigates the two-point bearing and the three-point bearing. Ill. 1600 w. Am Mach—Oct. 13, 1898. No. 23328.

Castings.

Reuniting Broken Iron Castings. Thomas F. Kennedy. Describes this method of repairing, and calls attention to points requiring special care. 1500 w. Met Work—Oct. 29, 1898. No. 23698.

Cast Iron.

Malleable Cast Iron. George C. Davis. Read before the Philadelphia Foundrymen's Assn. Gives its early history in the United States. 5500 w. Ir Age—Oct. 13, 1898. No. 23324.

The Melting Point of Cast Iron. Dr. R. Moldenke. Read before the Pittsburg Foundrymen's Assn. Describes and illustrates the Le Chatelier pyrometer modified for determining melting temperatures of cast iron, giving results obtained, and general observations. 2000 w. Ir Age—Oct. 20, 1898. No. 23439.

The Record of Seth Boyden's Experiments on Malleable Cast Iron. The first publication of Boyden's original manuscript. 10,000 w. Ir Age—Oct. 13, 1898 No. 23323.

Cone Pulleys.

Proportioning Cone Pulleys. John E Sweet. Presents the writer's method, of value to all who deal with cone-pulley design. Diagrams. 1500 w. Am Mach—Oct. 13, 1898. No. 23329.

Coremakers.

Girls as Coremakers. R. H. Palmer. An account of visits to several foundries where girls are employed, showing that it is a line of work that girls can use in making their living. 1800 w. Foundry—Oct., 1898 No. 23432.

Cost Keeping.

Cost Keeping and Accounting. W. S. Rogers. A paper, with discussion, before the N. Y. R. R. Club, giving methods used by the writer. 7500 w. N Y R R Club—Sept 15, 1898. No. 23398.

Effective Systems of Finding and Keeping Shop Costs. Henry Roland. A discussion of the various methods of determining and apportioning the expense account, including the relations of productive labor to general expense. 8500 w. Engineering Magazine—Nov., 1898. No. 23594 B.

Cupola Practice.

Modern Cupola Practice and the Physics of Cast Iron. Bertrand S. Summers. Condensed from a paper presented at the Am. Inst. of Min. Engs. Briefly considers the separate elements and their effects; examines tabulated analyses of various castings, and discusses other influences. 3800 w. Eng News—Oct. 6, 1898. No. 23247.

Drilling.

Nieustaedt's Improvements in Drilling Machines. From the *English Mechanic*. Illustrated description of mechanism for controlling the velocity in drilling. 1000 w. Prac Eng—Sept. 30, 1898. No. 23266 A.

Erection.

The Erection of a Locomotive in 66 hours. (Montage de Locomotive Exécuté en 66 Heures.) Describing this rapid piece of erection work in the Epernay works of the Eastern Railway of France. Several views are given showing successive stages of the work. 1000 w. Le Génie Civil—Oct. 1, 1898. No. 23504 D.

Gages.

Fitting Crown Brasses into Driving Boxes. Illustrated description of gages and method of using. 400 w. Am Mach—Oct. 20, 1898. No. 23447.

Gears.

An Odd Gear Pattern. John M. Richardson. Describes a pattern for a gear, made by the writer, used on a special machine for wrapping paper about oranges. 400 w. Am Mach—Oct. 20, 1898. No. 23446.

Suggestions on the Design of Corliss Valve Gears. John H. Barr. The paper explains certain expedients which have been found helpful in reaching a fairly satisfactory solution by trial on the drawing board. Gives method of determining the angle of advance of the eccentric, and method of projection directly from the virtual eccentric. Ill. 3300 w Sib Jour of Engng—Oct., 1898. No. 23472 C.

Hardening.

Continuous Heating Machine for Hardening Small Articles. Illustrated description of a machine designed for hardening quantities of bicycle balls, but also useful in hardening other work not exceeding 2½ in. in any dimension. 700 w. Ir Age—Sept. 29, 1898. No. 23069.

Nurnberg Works.

The Elektricitäts-Actiengesellschaft, Late Schnekert and Co., Nürnberg, Germany. Illustrated description of these works and their equipment, with history of the founder, Siegmund Schuckert. 2500 w. Engng—Oct. 14, 1898. Serial. Part 1. No. 23616 A.

Pattern Work.

Pattern Work that Helps the Molder. John

M. Richardson. Calls attention to points in the making and use of patterns which cause annoyance to the molder. 1500 w. Am Mach—Sept. 29, 1898. No. 23105.

Screw Machine.

The Spencer Automatic Screw Machine. Illustrated description of a machine designed for making all kinds of screws and studs, and also for cross-drilling pins and other parts for cycle and electric work. 2000 w. Engng—Sept. 30, 1898. No. 23295 A.

Steam Loop.

The Steam Loop. James Mackay. Illustrated description of this device and its operation. 1000 w. Dom Engng—Sept., 1898. No. 23058 C.

Turning Tool.

A Bezel Turning Tool. A. H. Cleaves. Illustrates and describes a tool of the writer's design used for turning down the rim of a brass bezel for holding a glass over a paper dial in one of the old watch style of cyclometers, and is recommended for similar work. 500 w. Am Mach—Oct. 13, 1898. No. 23330.

Type-Casting.

Rotary Type-Casting Machine. Illustrated description of the Wicks machine. 1400 w. Engr, Lond—Oct. 14, 1898. No. 23611 A.

Welding.

Welding of Metals. F. V. McMullin. A general discussion of the usefulness of this property and the methods used. 1600 w. Min & Sci Pr—Oct. 8, 1898. No. 23363.

Wire.

The Manufacture and Treatment of Wire for Electrical Purposes. J. Wright. Describes the various processes and treatments involved in the manufacture of wire from the raw material. 3800 w. Ind & East Engr—Sept., 1898. No. 23406 D.

MISCELLANY.

Automobiles.

A Steam Road Carriage. R. I. Clegg. Illustrates and describes an experimental steam carriage having interesting features, particularly in methods devised to secure automatic regulation of the fuel, steam pressure and water supply. 800 w. Am Mach—Oct. 6, 1898. No. 23264.

The Automobile Association (Limited). Illustrates and describes the more important vehicles in the collection of this company in England. They propose to supply all makes of moto-vehicles, including the best English and French types. 3800 w. Automotor Jour—Sept., 1898. No. 23040 A.

The Electric Vehicle Company. Outlines the problem of mechanical vehicles for street use, and the work undertaken by the company named. Ill. 2500 w. Am Mach—Sept. 29, 1898. No. 23104.

The Motor Carriage Industry. A review of the growth of this industry in various countries with an account of its present standing. Ill. 2000 w. Can Eng—Oct., 1898. No. 23299 A.

The R. A. S. E. Trials of Self-Moving Vehicles at Birmingham. Abstract of report of judges, signed by W. C. Unwin, and published in the Journal of the Royal Agricultural Society. 2000 w. Ind & Ir—Oct. 7, 1898. Serial. 1st part. No. 23413 A.

The Toward Steam Moto-Tractor. An official description with illustrations. 1200 w. Automotor Jour—Sept., 1898. No. 23041 A.

Cableway.

Building the Tramway Over Chilkoot Pass. W. A. Burkholder. States the conditions under which this aerial tramway was constructed, giving illustrated description of the D.-K. T. Co.'s tramway. 1500 w. Jour of Elec—Sept., 1898. No. 23637.

Chili.

Metallurgy in Chili. Henry Watson. Part first discusses the rich mineral deposits, value of the ores, sources of ore supply, sampling, treatment, kilns, smelting, &c. Aust Min Stand—Sept. 8, 1898. Serial. 1st part. No. 23332 B.

Design.

Influence of Natural Forms on Mechanical Design. W. H. Sargent. Notes some of the forms in nature that have been applied to mechanics. Ill. 600 w. Am Mach—Sept. 29, 1898. No. 23106.

Exhaust Steam.

Heating Value of Exhaust Steam. E. P. Roberts and I. H. Sherwood. Discusses the uses of exhaust steam, giving table of the properties of saturated steam, and showing the loss of its heating value to be a large waste. Ill. 2000 w. Engr, U. S. A.—Sept. 15, 1898. No. 23060.

Exposition.

The Mechanical Plant of the Universal Exposition of 1900. (Le Service des Installations Mécaniques à l'Exposition Universelle de 1900.) Ch. Dantin. Showing the present condition of work on the Champ-de-Mars and describing the manner in which the boilers, engines, electric generators and piping of the exposition power plant are to be installed. 3000 w. 1 plate. Le Génie Civil—Oct. 1, 1898. No. 23502 D.

Farm Machinery.

California Harvesting Machinery. Frank Corry. Illustrates and describes the Ladenberg traction engine and combined harvester as used on the Pacific coast. 500 w. Sci Am—Oct. 8, 1898. No. 23236.

Ladder.

A Peculiar Style of Ladder. Gives a description of the ladder and its operation. Ill. 1000 w. Sci Am Sup—Oct. 8, 1898. No. 23238.

Lock Nut.

The Dickertmann Conical Lock Nut. (Die Konische Sicherheitsmutter, Patent Dickertmann.) An ingenious form of lock nut in which the locking is accomplished by forcing a conical projection on the end of the nut into the bolt hole. 1800 w. Glaser's Annalen—Oct. 1, 1898. No. 23542 D.

Lubrication.

Lubrication and the Testing of Oil. G. W. Bissell. Discusses the judicious selection and application of the lubricants. Part first deals largely with the properties. 2200 w. St Ry Rev—Oct. 15, 1898. No. 23456 C.

Lubrication. From the *Engineer's Mag.* Discusses the various oils and other products used for this purpose, and means of testing. 2500 w. Mech Wld—Oct. 14, 1898. No. 23499 A.

The Testing of Lubricating Oils. (Die Prüfung der Maschinen-Schmieröle.) Carl Volk. showing the great reduction in friction by using Suitable lubricants, and dealing with methods of testing for viscosity and the detection of impurities. 1600 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 24, 1898. No. 23572 B.

Prony Brake.

Improved Spring Balance for Testing Electric Motors with the Prony Brake. (Verbesserte Federwaage für Bremsungen von Elektromotoren mit dem Prony'schen Zaum.) A. Wettler. A simple and delicate arrangement by which readings may easily be made, and power accurately computed. Full details of the apparatus are given. 1800 w. Elektrotech Zeitschr—Sept. 29, 1898. No. 23549 B.

Pump Test.

Test of a Snow Pump at Indianapolis. Report of trial of a 20,000,000-gal. triple-expansion pump giving 150,100,000-ft.-lbs. per million heat units supplied. 1300 w. Eng Rec—Oct. 15, 1898. No. 23359.

Pyrometers.

Metal Pyrometers. J. H. Kinealy. Considers the principles on which they operate and the care and skill needed to obtain reliable results. Ill. 1400 w. Mod Mach—Oct., 1898. No. 23436.

Refrigeration.

Mechanical Refrigeration. Peter Neff, Jr. A simple explanation of the principles of mechanical refrigeration. 1100 w. Engr, U. S. A.—Sept., 15, 1898. Serial. 1st part. No. 23064.

The Importance of Water for Refrigerating Machines. Alfred Siebert. Considers different types of refrigerating machines, showing how indispensable is water, the best method of expelling air, &c. 2500 w. Ice & Refrig—Oct., 1898. No. 23226 C.

Steam Cutting.

Cutting by Steam. James P. Hobart. Shows that pure steam does not cut, but that the action is produced by other substances carried by the steam. Cites examples. Ill. 1500 w. Am Elect'n—Oct., 1898. No. 23099.

Textile Machinery.

Improved Textile Machinery. (Neuerungen an Arbeitsmaschinen für die Textilindustrie.) G. Rohn. Illustrating and describing recent improved cotton spinning machinery used in the mills in Saxony. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 8, 1898. No. 23531 D.

Thermal Efficiency.

Losses of Heat in a Steam Plant. Gives a diagram reproduced from the report recently issued by a committee of the Institution of Civil Engineers. It was made by Capt. Sankey, and shows the various heat losses in a real and an ideal steam plant. Also a summary of the recommendations of the committee. 3000 w. Eng News—Oct. 20, 1898. No. 23462.

Thermometer.

A Giant Thermometer. An account of a large thermometer being made in England to register the earth's heat. It is seventy feet in length. 800 w. Bos Jour of Com—Sept. 24, 1898. No. 23045.

Torsion.

Instruments for Measuring Small Torsional Strains. E. G. Coker. Read at Bristol meeting of the British Assn. for the Adv. of Science. Describes two arrangements of apparatus intended for use in engineering laboratories and testing-houses for measuring such strains, and for the determination of the modulus of rigidity. Ill. 2000 w. Engng—Oct. 14, 1898. No. 23620 A.

U. S. Patents.

The United States Patent Office. An editorial criticism of this department of the United States government. 1200 w. Engng—Sept. 30, 1898. No. 23296 A.

Vacuum Bottle.

Les Verseurs Hermetiques. H. Joshua Phillips. Illustrated description of patent of Baron de Sennevoy—a device which permits any amount of liquid to be drawn from a bottle without admission of air or other substance. 1600 w. Ind & Ir—Sept. 23, 1898. No. 23227 A.

MILITARY ENGINEERING.

MILITARY ENGINEERING.

Aluminum.

The Use of Aluminum in the French Army. (Emploi de l'Aluminium dans l'Armée Française.) Showing the saving in weight by the use of aluminum cooking utensils, &c., and the extent to which they have been placed in the French army. 800 w. La Revue Technique—Sept. 25, 1898. No. 23512 D.

American Navy.

The United States Navy Under the New Conditions of National Life, P. H. Colomb. Considers the necessary changes and the expense that must be incurred to protect newly acquired territory, giving suggestions of a system of defense. 4500 w. N Am Rev—Oct., 1898. No. 23209 D.

The Navy in the War with Spain. Ira Nelson Hollis. Reviews the history of the naval part of the war and what the United States learned of value to naval development. 7000 w. Atlantic M—Nov., 1898. No. 23680 D.

Armor.

The Production and Supply of Armor for Naval Purposes. Introduction and outline of subject, with early armor experiments and their results comprise this first part. Ill. 3000 w. Ir & Coal Trds Rev—Sept. 23, 1898. Serial. 1st part. No. 23140 A.

Battleships.

Chief Characteristics of Battleships and Monitors Provided for in Naval Shipbuilding Programme of 1898 99. Outlines the leading features of design of the battleships and monitors to be constructed. 2200 w. Marine Engng—Oct., 1898. No. 23190 C.

Machinery of the "Maine." One of the three new battleships to be built is to be called the Maine. It is to be of the same general plan as the Alabama, and this article notes the changes which are to be made in the machinery. 1000 w. Bos Jour of Com—Oct. 1, 1898. No. 23151.

Our Latest Battleship. Brief description of the "Illinois," which was launched Oct. 4, 1898. 1200 w. Sci Am—Oct. 15, 1898. No. 23344.

Bombardment.

The Bombardment of Coasts. (Les Bombardments de Côtes.) Léo Dex. A discussion of the relative advantages of vessels and fortifications in connection with the attack and defense of coasts showing the importance of mortar fire with high trajectory against modern war ships. 2000 w. La Revue Technique—Sept. 25, 1898. No. 23508 D.

Cable Cutting.

Cable Cutting in War. George Ethelbert Walsh. Discusses the effect produced by cutting the cables and the means of protecting them in time of war. 2000 w. N Am Rev—Oct., 1898. No. 23210 D.

Cruiser.

Protected Cruiser "Philadelphia," of the United States Navy. Engraving and brief description of this cruiser which had the honor of carrying the annexation commission to Honolulu. 900 w. Sci Am—Oct. 1, 1898. No. 23084.

Disarmament.

See Economics and Industry, Miscellany.

Electricity.

The Use of Electricity in the Spanish American War. Thomas G. Grier. Paper read before the Chicago Elec. Assn. Summary of the applications, describing the methods employed at Fort Wadsworth, just below New York, the mines in Boston harbor, and other devices. 3000 w. Elec Wld—Oct. 15, 1898. No. 23326.

Gunnery.

Our Own Latest Marvel of Gunnery. Relates to the new "high angle firing" weapon soon to be introduced into the American navy. It is capable of being elevated so as to stand almost vertical with the deck, if necessary. 1100 w. Engng Mech—Oct., 1898. No. 23661 C.

H. M. S. Terrible.

The Steam Trials of H. M. S. "Terrible." A review of the results of recent trials. 2800 w. Engng—Sept. 30, 1898. No. 23297 A.

Merrimac.

The Sinking of the Merrimac. R. K. Crank. A detailed description of what happened in the engine room, given by the chief engineer. 3500 w. Am Mach—Oct. 6, 1898. No. 23263.

Naval Engineers.

The Modern Naval Engineer. Editorial discussion of the proposed change in personnel in the U. S. navy, and referring to the British views on the subject. 1400 w. Eng News—Oct. 27, 1898. No. 23676.

Naval Manoeuvres.

The French Naval Manœuvres of 1898. Editorial account of the manœuvres of the Mediterranean Squadron is given in part first. 2000 w. Engng—Oct. 7, 1898. Serial. 1st part. No. 23416 A.

Ordnance.

Naval Ordnance. Extract of the more important features of the annual report of the Bureau of Naval Ordnance of the United States, dealing with guns and mounts, small guns, efficiency, smokeless powder, and armor. 2400 w. Ir Age—Oct. 27, 1898. No. 23686.

On the Action of the Projectile and of the Explosives on the Tubes of Steel Guns. W. C. Roberts-Austen. Read before the Iron and Steel Inst., at Stockholm. A thorough examination shows that the action of the explosive upon the mass of the tube is purely mechanical, but at the extreme edge there is an altered layer. 1200 w. Ir & St Trds Jour—Sept. 17, 1898. No. 23169 A.

Report.

Report upon the Condition of Admiral Cervera's Vessels. Report in full after an examination by a Board of U. S. Naval Officers. Special attention is given to the effect of the U. S. gun fire, of combustible material, and explosions, with the conclusions drawn by the Board. Illustrations showing number and location of hits. 3000 w. Marine Engng—Oct., 1898. Serial. 1st part. No. 23192 C.

Sanitary Aspects.

Medical and Sanitary Aspects of the War. Dr. Carroll Dunham. A survey of the events of the late war in so far as they bear upon the health of the men. 9800 w. Am Rev of Revs—Oct., 1898. No. 23161 C.

Submarine Mines.

Explosion of Submarine Mines in Baltimore Harbor. Some account of the various kinds of mines with photographs showing their terrific energy. 1200 w. Sci Am—Oct. 1, 1898. No. 23085.

Torpedo Boats.

Torpedo-Boats for the Austrian Navy. Editorial on the trial trip of the "Boa," one of the vessels built for the Austro-Hungarian government, with general remarks on this class of

marine construction. 1700 w. Engng—Sept. 23, 1898. No. 23147 A.

Torpedo-Boats in the War with Spain. John R. Spears. Reviews what these boats did in the war, showing that they served mostly as dispatch-boats, and pickets. That they could not resist modern rifle projectiles, but that this is the most dangerous service, and did much to improve the *personnel* of the navy. 4200 w. Scribner's Mag—Nov., 1898. No. 23652 C.

See Electrical Engineering, Lighting.

War Costs.

The Cost of the War. Frank A. Vanderlip. An interesting article by the assistant secretary of the Treasury, discussing the cost of the war with Spain. 4000 w. McClure's Mag—Oct., 1898. No. 23180.

War Engineering.

The Work of the Engineers in the Santiago Campaign. Eduardo J. Chibas. Map of the district around Santiago, showing the positions of the United States and Spanish forces, with a statement of the work done by the engineers during the advance. 3500 w. Eng News—Oct. 13, 1898. No. 23334.

War Lessons.

Some Lessons of the War from an Officer's Standpoint. John H. Parker. Considers some of the causes of needless suffering, and some of the changes that have been made necessary by improved rifles and by the use of the machine gun. 3800 w. Am Rev of Revs—Oct., 1898. No. 23162 C.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

Causes of Accidents. Extracts from the reports of the several mine inspectors of the State of Pennsylvania regarding the causes of accidents in mines. Also some recommendations by which the number of injuries may be reduced. 4000 w. Mines & Min—Oct., 1898. No. 23171 C.

Reports on the Whitwick Colliery Accident. Report on the circumstances attending an underground fire and which resulted in the loss of thirty-five lives. 6600 w. Col Guard—Sept. 23, 1898. No. 23134 A.

Breaker.

The New Breaker at Cranberry Coal-Mine, Hazleton, Pa. W. S. Ayres. A detailed description of the new breaker, made necessary by a destructive fire, considering the foundations, frame of structure, machinery, chutes and connections, with a statement of results. Ill. 10,500 w. Am Inst of Min Engs—Oct., 1898, No. 23381 D.

Boiler Plant.

Mine Boiler Plant at Hazleton Shaft Colliery of the Lehigh Valley Coal Co., Hazleton, Pennsylvania. An illustrated description of a thoroughly modern plant using forced and induced draft, economizer, and water for removing ashes from the boiler room. 2000 w. Mines & Min—Oct., 1898. No. 23173 C.

Brick-Making.

Brick-Making from Coal-Measure Shale. From a communication by M. Sylva Cottier to the Soc. of Hainaut Mining Engs. Describes the work as carried on by the Marles Colliery Co. in the north of France. 1300 w. Col Guard—Sept. 30., 1898. No. 23288 A.

By-Products.

Modern Appliances for the Recovery of By-Products from Coking Coal. From *Stahl und Eisen*. Describes a German plant and the manner of recovering the products. 1500 w. Gas Wld—Oct. 15, 1898. No. 23603 A.

Some Notes on Recovery Plant in By-Product Coking. Rudolph Terhaerst in *Stahl und Eisen*. General remarks on by product plants, with description of ovens and condensing apparatus. 1800 w. Ir & Coal Trds Rev—Sept. 23, 1898. No 23139 A.

Carboniferous Rocks.

The Yoredale Series. Wheelton Hind. Read before the Geological Soc. of London. Information concerning the carboniferous rocks of Great Britain. 5000 w. Col Guard—Oct. 14, 1898. Serial. 1st part. No. 23609 A.

Coal-Cutting.

Coal-Cutting by Machinery. G. C. Allsebrook. Abstract of a paper which has been awarded the annual prize of £5 offered by the Inst. of Min. Engs. for the best essay written by a student or member under twenty-five years of age. Shows the need of coal-cutting machinery, the advantages from its introduction, the effect upon the workmen, the essentials of a good machine, &c. 2400 w. Col Guard—Oct. 7, 1898. No. 23411 A.

Coal Cutting by Machinery. W. E. Garforth. A contribution to the discussion of W. T. Goolden's paper, read at the London meeting of the Inst. of Min. Engs. Ill. 1600 w. Col Guard—Sept. 23, 1898. No. 23131 A.

Coal Handling.

The Automatic Manipulation of Coal and Coke. Gilbert Little. Abstract of a paper read before the Inst. of Mining Engs. describing several systems of machinery for dealing economically with the loading, distribution and cleaning. 1300 w. Col Guard—Sept. 30, 1898. No. 23290 A.

Coal-Handling Machinery. Notes the causes which have led to the development of economical methods of handling coal in power stations, giving illustrated descriptions of some of the installations. 1600 w. St Ry Rev—Oct. 15, 1898., No. 23454 C.

Coal Region.

The Blossburg Coal Region. Anton Hardt. Its location and geology, the mining methods and machinery used, also analyses of the coals from different mines. 1500 w. Mines & Min—Oct., 1898. No. 23178 C.

Coal Trade.

See Economics and Industry, Commerce and Trade.

Coke Making.

Coke Making for Profit. Fred C. Keighley. Part 1st discusses the most profitable plant, giving facts of interest to those in the coke business. 2300 w. Am Mfr & Ir Wld—Sept. 30, 1898. Serial. 1st part. No. 23214.

Colliery Warnings.

Colliery Warnings: Their Utility Called in Question. W. Fairley, in *Mining Engineering*. Considers that no instrument yet constructed can give warning of the approach of firedamp. 1000 w. Can Min Rev—Sept., 1898. No. 23166 B.

Competition.

The Competition of West Virginia with Ohio Coal. E. H. Coxe. A statement of some of the conditions governing this competition. 1200 w. Eng & Min Jour—Oct. 8, 1898. No. 23194.

Fifeshire.

A Visit to Fifeshire Collieries. Notes on features of interest observed at Dalbeath, Mossbeath, Kirkwood Pit and Aitken Pit. 2000 w. Col Guard—Oct. 7, 1898. No. 23410 A.

India Collieries.

The Indian Railway Coal Supplies and Indian Collieries. Brief account of the collieries which chiefly supply the Indian railways, their outputs, and the quantity of coal raised per person employed. 1800 w. Ir & Coal Trds Rev—Oct. 14, 1898. No. 23614 A.

New South Wales.

The Coal Mines of New South Wales. Extracts from a very complete report by A. A. Atkinson, discussing ventilation, methods of working, haulage, lighting of mines, and methods of signalling. 1800 w. Ir & Coal Trds Rev—Sept. 30, 1898. No. 23279 A.

Peru.

Anthracite Coal in Peru. William Griffith. The geology and extent of the deposits and the qualities of the coal found in them. 1500 w. Mines & Min—Oct., 1898. No. 23176 C.

Preparation.

The Mechanical Preparation Works at the St. Eloy Collieries. (Atelier de Préparation Mécanique aux Houillères de Saint Eloy, Puy-de-Dôme.) A fully illustrated account of the conveyors, travelling belts, washing apparatus, &c., with plans of the general installation of the plant. 1800 w. Le Génie Civil—Sept. 17, 1898. No. 23500 D.

Pumping Plant.

New Electric Pumping Plant at Arniston Colliery, Gorebridge, N. B. Describes the plant, which, exclusive of the building of the power stations, has cost about £12,000. 900 w. Col Guard—Sept. 23, 1898. No. 23132 A.

South Africa.

South African Coal. Editorial on the trials and results to ascertain the relative value of the various kinds of coal used by the locomotive department of the government railways. The coals tried were the Welsh, Cape Colonial, Orange Free State and Transvaal. 1100 w. Engng—Oct. 14, 1898. No. 23618 A.

Stocking Plant.

Plant for Stocking, &c., Patent Fuel at a French Colliery. M. Castellan. Communicated to the Société de l'Industrie Minérale. Illustrates and describes the arrangements for stocking *boulets*, a fuel made of fine slack from anthracite. 1200 w. Col Guard—Oct. 7, 1898. No. 23408 A.

COPPER.

Converter.

The Paul David "Selecteur" or Converter. Paul Louis Barthe. Abstract of article in the *Annales de Mines*. Illustrates and describes improved apparatus used in the metallurgy of copper, its working, and advantages. 2200 w. Eng & Min Jour—Oct. 22, 1898. No. 23633.

Copper Depositing.

The Dumoulin Copper Depositing Process. John B. C. Kershaw. Describes the manufacture of copper tubes and sheets by electrolytic deposition. Ill. 1500 w. Elec Rev, Lond—Oct. 14, 1898. No. 23492 A.

Copper-Mattes.

The Elimination of Impurities from Copper-Mattes in the Reverberatory and the Converter. Edward Keller. A contribution to the discussion of this paper, giving the writer's reply to the remarks of Dr. Peters. 2400 w. Am Inst of Min Engs—Oct., 1898. No. 23380 D.

GOLD AND SILVER.

Address.

The President's Inaugural Address. J. Loevy. Address before the society dealing with chemical subjects directly or indirectly connected with the metallurgy of gold. 3800 w. Jour of Chem & Met Soc of S Africa—Aug., 1898. No. 23224 E.

Assaying.

A New Assay for Mercury. Richard E. Chism. Shows the uncertainty of some methods, the drawbacks of the gold method, and describes the use of silver for receiving the mercury. 2500 w. Am Inst of Min Engs—Oct., 1898. No. 23373 D.

Chlorination.

The Chlorination Mill at Colorado City, Colorado. H. V. Croll. Brief description of plant designed to treat the ores of Cripple Creek and other districts. Ill. 1800 w. Eng & Min Jour—Oct. 8, 1898. No. 23195.

Concentration.

Concentration. S. J. Hallett. Describes coarse and fine concentration. 1600 w. Min Rept—Oct. 6, 1898. No. 23320.

Cyanide.

Aids to the Cyanider. Matt W. Alderson. The paper aims to show how certain well known facts may be utilized to advantage in every day work, and how tests may be made and conclu-

sions reached without the aid of a chemist. 2300 w. Min & Sci Pr—Oct. 15, 1898. No. 23471.

The Estimation of Oxygen in Working Cyanide Solutions. Andrew F. Crosse. A contribution to analytical chemistry giving a simple method of determining the amount of oxygen in cyanide solutions. 3300 w. Jour of Chem & Met Soc of S Africa—Aug., 1898. No. 23225 E.

Electrodeposition.

The Electro-deposition of Gold in the Transvaal. (L'Electrodéposition de l'Or au Transvaal.) Dr. Andréoli. An account of the practical operation of the Siemens & Halske process in South Africa. Serial. Part I. 1500 w. Electricien—Oct. 1, 1898. No. 23555 B.

Gippsland, Victoria.

Notes on the Auriferous Devonian Formations of Gippsland, Victoria. H. Herman. The writer concludes that there is not yet sufficient reason for altering the opinion that the great mass of the Upper Devonian rocks of Victoria should be considered, in general, non auriferous. 3500 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23390 G.

Gold Dredging.

Hydraulic Dredging, or the Working of Deep Alluvial Deposits by Elevation with Centrifugal Pumps. A. S. Kenyon. Illustrates and describes the system in use. 3000 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23393 G.

Notes on Gold-dredging, with Reference to the Introduction of the Industry into New South Wales. J. B. Jaquet. A report upon the results obtained and the machinery used. 7500 w. N Z Mines Rec—Sept. 16, 1898. No. 23645 B.

Goldfield.

A Neglected Goldfield. An account of the Inglewood reefs, in Victoria, showing that a course of systematic mining would give satisfactory results. 2200 w. Aust Min Stand—Aug. 18, 1898. Serial. 1st part. No. 23308 B.

Berringa, Vic. An illustrated account of this field discussing its prospects. 1600 w. Aust Min Stand—Sept. 15, 1898. No. 23646 B.

Gold-Milling.

Some Notes on Gold-Milling. W. H. Vale. Results of the writer's experience, showing from an economic point of view, what he has found best suited to his particular work. 2200 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23387 G.

Gold Structure.

Microscopic Structure of Gold and Gold Alloys. Thomas Andrews. An account of a series of experiments to determine the microphysical structure. Part first considers the structure of pure gold. Ill. 1000 w. Engng—Sept. 30, 1898. No. 23294 A.

Kalgoorlie.

Kalgoorlie, Western Australia, and its Surroundings. Edward S. Simpson's discussion of this paper, with reply by the writer, George J. Bancroft. 1200 w. Am Inst of Min Engs—Oct., 1898. No. 23375 D.

Klondike.

Notes from the Klondike. A. N. C. Treadgold. Descriptive of the region and existing conditions. 4500 w. Can Min Rev—Sept., 1898. No. 23164 B.

The Country of the Klondike. Russell L. Dunn. Statements based on observations and information obtained during a recent visit to the basins of the Yukon and Alsek rivers. 2800 w. Min & Sci Pr—Oct. 22, 1898. Serial. 1st part. No. 23683.

The Klondike Gold Fever. D. Zahn. Translated from *Ueber Land und Meer*. An account of the rush to this field, difficulties of travelling and living, with report of one who made the journey. 1400 w. Chau—Nov., 1898. No. 23682 C.

Lode-Locations.

Mineral Lode-Locations in British Columbia. William Braden. An account of the trial and abandonment of this feature, and the working of the Mineral act as it stands to-day. 1500 w. Am Inst of Min Engs—Oct., 1898. No. 23378 D.

Mercur.

Gold Mines of Mercur, Utah. Don Maguire. How the large bodies of low grade ores found there are profitably treated, with description of some of the peculiar ore deposits, the chemical problems their treatment presents, and the methods by which they are solved at the Golden Gate mines. 2700 w. Mines & Min—Oct., 1898. No. 23179 C.

New Zealand.

Minerals in the Gold-Bearing Reefs of the Thames. F. B. Allen. Considers minerals other than pyrites which are found on the Thames goldfield. 2400 w. N Z Mines Rec—Aug. 16, 1898. No. 23052 B.

Nova Scotia.

The Ores of Nova Scotia. From a report by E. Gilpin, Jr. Deals largely with the gold and silver ores, but mentions rich deposits of copper, coal, iron ore, gypsum and other minerals. 4000 w. Col Guard—Sept. 30, 1898. No. 23289 A.

Ore Deposits.

The Superficial Alteration of Western Australian Ore-Deposits. Herbert C. Hoover. Describes the nature of the deposits and points out the special peculiarities of the phenomena observed in Western Australia. 2500 w. Am Inst of Min Engs—Oct., 1898. No. 23374 D.

Placer Gold.

Placer Gold and How It Is Secured. John E. Bennett. An explanation of what placers are, how formed, and an illustrated description of the methods of placer mining. 3500 w. Cos—Nov., 1898. No. 23430.

Refining.

The Refining of Base Lead Bullion Containing Silver, and High in Gold. G. H. Blakemore. Describes the operation of refining base bullion. 10,000 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23391 G.

Silver Ores.

The Reduction Works for Silver Ores, at

Aduana, Sonora, Mexico. Miltiades Th. Armas. A brief geographical description, the kinds of ores and methods applied. 2700 w. Jour Fr Inst—Oct., 1898. Serial. 1st part. No. 23203 D.

Slimes.

A Few Notes and Observations on the Reduction and Ore Dressing of Auriferous Quartz Veinstone in Victoria. Henry Rosales. Deals with the methods practiced on several of the goldfields of Victoria, especially the systematical treatment of slimes. 3400 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23384 G.

Treatment of Slimes. W. B. Gray. Gives experience in the treatment of the water which overflows from the cyanide vats and carries off the slimes in suspension, dealing with the collection of the slimes, their treatment by cyanide, and the precipitation of the gold by charcoal. 1500 w. Trans Aust Inst. of Min Engs—Vol. V. No. 23388 G.

Smelting.

Reverberatory Furnace Smelting of Ores. Thomas J. Dyson. Describes a method in use at a European smelting works, based on the mutual reduction of oxide and sulphide of lead when heated together. 1400 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23383 G.

Smelting Gold and Silver Ores in Colorado. Thomas Tonge. The development of the industry and its effects on the mining business. The locations and capacities of the plants and statistics in regard to their output of precious and other metals. Ill. 3700 w. Mines & Min—Oct., 1898. No. 23170 C.

Source of Metals.

The Source of Gold and Other Metals. Henry A Gordon. Abstract of a paper read before the New Zealand Inst. of Min. Engs. Discussing where metallic substances come from and quoting the opinions of many writers. 4000 w. N Z Mines Rec—Aug. 16, 1898. No. 23051 B.

Witwatersrand.

Some Notes on the Mining Practice of the Witwatersrand Goldfields, South African Republic. G. A. Denny. Calls attention to the features peculiar to this district, and describes the mining methods, which represent the most advanced teaching of modern science and experience. Ill. 20,000 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23382 G.

Yukon.

The Yukon Royalty. A. N. C. Treadgold. Discusses the justice of the royalty imposed, concluding that the crown keeps back too much considering the conditions. 1500 w. Can Min Rev—Sept., 1898. No. 23163 B.

IRON AND STEEL.

Analysis.

The Physical Analysis of Steel. John Parry. Read before the South Wales Inst. of Engs. The writer has attempted to collect the essential facts, useful to the manufacturer, that have been obtained by microscopical investigations. 3300 w. Col Guard—Sept. 23, 1898. No. 23136 A.

Birmingham, Ala.

A Great Outlook for Birmingham. James Bowron. Full text of address at the Cincinnati meeting of the Am. Foundrymen's Assn. A statement of the conditions which have helped to advance the iron and steel industries at this place, the importance of the coal deposits, &c. 4000 w. Ir Trd Rev—Sept. 22, 1898. No. 23059.

Blast Furnaces.

Iron Carbonyl in the Blast Furnace. F. P. Venable. Some facts with regard to the possible part played by this compound in blast furnace processes. 900 w. Am Mfr & Ir Wld—Oct. 28, 1898. No. 23703.

Iron Extraction.

The Extraction of Iron from Its Ores in the Blast Furnace. James Tomkins. From a paper read before the Derbyshire Metallurgical and Engineering Assn. Deals with the treatment of the iron ore in the furnace. 2500 w. Col Guard—Sept. 30, 1898. No. 23291 A.

Iron Formation.

An Extensive Iron Formation, West Coast of Tasmania. David Jones. Describes one of the largest deposits of iron known in Tasmania, and probably in the world. 2000 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23386 G.

Iron Mixer.

The Jones Iron Mixer Patent. Illustration and a summary of the specifications of this patent, the object of which is to make the product of the converters as uniform as possible. 1300 w. Eng & Min Jour—Oct. 1, 1898. No. 23103.

Iron Works.

The Hofors Iron Works, Sweden. Illustrated description. 2500 w. Engng—Oct. 7, 1898. No. 23414 A.

The Plant of the Pencoyd Iron Works, Pencoyd, Pa. Detailed description with drawings and illustrations. 4500 w. Eng News—Sept. 29, 1898. No. 23073.

Reversing Engine.

See Mechanical Engineering, Engines.

Review.

Review of Recent Progress in the Metallurgy of Iron. (Revue des Progrès Récents de la Metallurgie du Fer.) MM. de Billy & Marillier. The annual review of the *Société d'Encouragement*, giving a résumé of the notable advances made during the year. 7500 w. Bulletin de la Société d'Encour—Sept., 1898. No. 23517 G.

Rolling Mills.

Improvements in Rolling Mills. Condensed from account by E. Weber, in *Stahl und Eisen*. Illustrated description of a proposed new arrangement for roll trains. 1700 w. Ir & Coal Trds Rev—Sept. 30, 1898. No. 23278 A.

The New Plate Rolling Mills of the Rasselstein Iron Works. (Das Neue Platinenwalzwerk

der Rasselsteiner Eisenwerks Gesellschaft.) A brief account of these new rolling mills in Rhenish Prussia, with plate of plans and sections. 1000 w. 1 plate. Stahl und Eisen—Oct. 1, 1898. No. 23563 D.

The New Strip Mills of the Rasselstein Ironworks. From *Stahl und Eisen*. Illustrated detailed description of a mill in Germany presenting features of interest. 700 w. Ir & Coal Trds Rev—Oct. 14, 1898. No. 23615 A.

Russia.

The Development of the Russian Iron and Steel Industry. From the London *Times*. Facts showing the growth of this industry. 1400 w. Col Guard—Sept. 23, 1898. No. 23135 A.

Santiago.

Santiago Iron Mines. An illustrated description and history of the principal iron and manganese mines of Cuba, by whom they are operated, the quality of the ores, the methods by which they are mined, and the facilities for handling and transportation. 2000 w. Mines & Min—Oct., 1898. No. 23174 C.

Scotland.

The Ironmaking Districts of Scotland. Part first describes the tube industry of Coatbridge. Ill. 1300 w. Ir & Coal Trds Rev—Sept. 23, 1898. No. 22138 A.

Steel Production.

Jones & Laughlin Co., Ltd., and the Production of Steel. A description of the plants and equipment of a modern metal working establishment near Pittsburg. 2000 w. Elec Eng, N. Y. —Oct. 20, 1898. Serial. 1st part. No. 23443.

MINING.

Economics.

On the Economics of Mining. J. R. Godfrey. Discusses methods of exploiting a mine, flotation and over-capitalization, management, and the steps that should be taken to prevent loss. 6000 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23389 G.

Explosives.

Testing Mining Explosives. Perry F. Nursey. A discussion of the first report of Captain Cooper-Key, upon the work at the government testing station at Woolwich, where explosives are searchingly tested. 2400 w. Ind & Ir—Sept. 30, 1898. No. 23281 A.

Firedamp.

The Firedamp Explosions in the Upper Dortmund District. (Die Schlagwetterexplosionen im Oberbergamtsbezirk Dortmund.) A tabulated report of the mine explosions of 1897, with a chart of barometric curves, showing the relation of explosions to atmospheric pressure. 2000 w. 1 plate. Glückauf—Sept. 17, 1898. No. 23567 B.

Forest Reserves.

Mining and the Forest Reserves. Gifford Pinchot. A brief statement of the regulations prescribed under the law, showing that the reservation does not interfere with the development of mineral wealth, but is of positive value to the miners. 2800 w. Am Inst of Min Engs—Oct., 1898. No. 23379 D.

Haulage.

Mining Haulage. G. W. Westgarth. From the *Journal of the British Society of Mining Students*. Deals with haulage underground, suggesting where economy may be effected, and showing how installations are rendered unsatisfactory by a misapplication of the load. 7800 w. Can Min Rev—Sept., 1898. No. 23165 B.

Mine Accounts.

Keeping Mine Accounts. Deals with the arrangement of mine accounts for the cost sheet rather than the method of keeping them in detail. 2000 w. Ir & Coal Trds Rev—Sept. 23, 1898. No. 23137 A.

Mining Contracts.

Questions Arising on Mining Contracts. Gives cases illustrating the sort of questions arising and of the principles of British law that are applied to their decision. 3000 w. Col Guard—Sept. 30, 1898. No. 23286 A.

Mining Plant.

Improvements in Mining Plant and Methods. From an official report on the working of the Prussian mines during 1897. Part first deals mainly with blasting. 2500 w. Col Guard—Sept. 30, 1898. Serial. 1st part. No. 23285 A.

Pelton Wheel.

The Applications of the Pelton Motor in Mining Work. (Ueber den Pelton motor und seine Anwendung im Bergwerksbetrieb.) C. Blecken. Showing the especial applicability of wheels of this class to mining service. 2000 w. Glückauf—Oct. 1, 1898. No. 23569 B.

Preservation.

The Hasselmann Impregnating Process. (Ueber das Hasselmannsche Imprägnierungs-Verfahren.) Max Krause. A method of charging the pores of wood with chloride of zinc, claimed to be especially adapted for mine timbers. 2000 w. Glückauf—Sept. 24, 1898. No. 23568 B.

Respirators.

Improved Life Saving Respirators. (Les Nouveaux Appareils Respiratoires de Sécours.) H. Schmerber. Describing particularly the pneumatophore of Walcher & Gaertner, and also the Mayer & Pilar apparatus. The carbonic acid of the breath is absorbed by caustic potash, and a supply of compressed oxygen is carried. 2500 w. Le Génie Civil—Oct. 1, 1898. No. 23503 D.

Tasmania.

Tasmanian Mining Laws. J. W. Hudson. A statement of reforms that the writer considers necessary to make this field attractive to capitalists 2400 w. Aust Min Stand—Sept. 8, 1898. No. 23331 B.

Timbering.

The Applicability of Certain Kinds of Wood for Mine Timbers. (Ueber die Gebrachsfähigkeit einiger Holzarten zum Grubenausbau.) Ch. Dütting. Giving the results of endurance tests of various kinds of mine timbers, and methods

of timber preservation. 2500 w. Glückauf—Oct. 8, 1898. No. 23570 B.

Timbering in the Iron Ore Mines of Cumberland and Furness. John L. Hedley and William Leck. Abstract of a paper read before the Inst. of Engs., England. 2200 w. Col Guard—Sept. 23, 1898. No. 23133 A.

MISCELLANY.

A. I. M. E. Meeting.

The Mining Engineers meeting of the American Institute at Buffalo. A brief account of the meeting with abstracts of papers presented. 7500 w. Ir Age—Oct. 27, 1898. No. 23685.

Aluminum.

Aluminum as a Reducing Agent and a Source of High Temperatures. The investigations of Dr. Hans Goldschmidt are reported, which have made it possible to produce metals on a large scale and to utilize in other ways the temperature produced by the reaction. Explains its use in the production of metallic chrome and manganese and of corundum. 1500 w. Ir Age—Oct. 6, 1898. No. 23239.

Ashcroft Process.

The Ashcroft Process for the Treatment of Mixed Lead and Zinc Sulphide Ores. Walter Renton Ingalls. A statement of the difficulties encountered at Cockle Creek, N. S. W., and some of the features involved in the problem. Also editorial. 5000 w. Eng & Min Jour—Oct. 22, 1898. No. 23634.

Clay.

Clay Resources of Missouri. H. A. Wheeler. These clays comprise all the varieties used in the arts and are found in great abundance. 2200 w. Eng & Min Jour—Oct. 8, 1898. No. 23196.

Clays of Louisiana. W. W. Clendennin. Report of the deposits thus far known, which when developed, give promise of becoming an important source of wealth. 900 w. Eng & Min Jour—Oct. 15, 1898. No. 23405.

Corundum.

Corundum. Extract from the report of the Ontario Bureau of Mines, 1898. The conditions under which the mineral occurs, its varieties, composition, &c. 3200 w. Can Eng—Oct., 1898. No. 23304.

Diagrams.

Note on the Use of the Tri-Axial Diagram and Triangular Pyramid for Graphical Illustration. Henry M. Howe. Calls attention to the tri-axial diagram as a convenient means of illustrating the properties of slags, and commends it to those inclined to graphical studies, having other possible applications. 2200 w. Am Inst of Min Engs—Oct., 1898. No. 23372 D.

Fire Brick.

Bauxite Firebrick. Calls attention to this variety of firebrick, also describing magnesia and other brick. 800 w. Clay Rec—Sept. 26, 1898. No. 23400.

Fire Clays.

A Modification of Bischof's Method for Determining the Fusibility of Clays, as Applied to Non-Refractory Clays, and the Resistance of Fire-Clays to Fluxes. H. O. Hofman. Explains the direct and indirect methods, and describes the modification and the experimental tests made to verify the method. 1500 w. Am Inst of Min Engs—Oct., 1898. No. 23377 D.

Does the Size of Particles Have any Influence in Determining the Resistance of Fire-Clays to Heat and to Fluxes? H O Hofman, and B. Stoughton. Report of a series of tests made, giving tabulated results. 800 w. Am Inst of Min Engs—Oct, 1898. No. 23376 D.

Gas Producers.

Gas Generators Albert Sailler. A lecture delivered before the Austrian Assn. of Engs. and Architects. Translated from the *Zeitschrift für das Gas und Wasserfach*. Discusses principally the metallurgical apparatus in which the fractional combustion of fixed carbon is involved, describing his own system, and giving results. 2500 w. Pro Age—Oct. 15, 1898. No. 23362.

The Riche Gas Producer. A. Lombard. Translated from the French. Describes the producer and its working. 1200 w. Am Mfr & Ir Wld—Oct. 7, 1898. No. 23312.

Glass.

Continuous Operation in the Manufacture of Window Glass. Robert Linton. Especially devoted to the history of the development of the continuous tank furnace as opposed to the older melting pots; with illustrations of German, French, and American furnaces. 3000 w. Engineering Magazine—Nov., 1898. No. 23597 B.

India.

See Economics and Industry, Commerce and Trade.

Kryolith.

Kryolith—Its Mining, Preparation and Utilization. The only deposit of commercial importance known is in Greenland. Its principal use is in the manufacture of soda. 2000 w. Min & Sci Pr—Oct. 1, 1898. No. 23232.

Marble.

The Marble Mountains of Italy. Vernon Lee. Descriptive. 1500 w. Stone—Sept., 1898. No. 23037 C.

Metal Working.

The Spinning, Stamping, and Working of Aluminum and Brass Sheet. From the *Aluminum World*. The more general use of the aluminum sheet is noted and some facts related to its working. 1600 w. Sci Am Sup—Oct. 15, 1898. No. 23346.

Nickel.

Nickel. Arthur Lakes. Its ores and some of their distinguishing peculiarities. Where they are found. 1000 w. Mines & Min—Oct., 1898. No. 23177 C.

The Mining, Smelting, and Refining of Nickel. Titus Ulke. With views of the mines and smelting works, and a detailed account of the methods and costs of nickel production. 3000 w. Engineering Magazine—Nov., 1898. No. 23595 B.

Petroleum.

Southern California Petroleum. A. S. Cooper.

Describes the Summerland oil-field. Nearly all the oil found in California is in dunes. Petroleum is pumped from under the sea. Ill. 600 w. Min & Sci Pr—Oct. 15, 1898. No. 23469.

Platinum.

The Platinum Metals of Plumas County, California. J. A. Edman. Some notes on platinum, with iridium, osmiridium, and iridosmium, found in several of the deep gravel channels and in some surface gravels. 1000 w. Min & Sci Pr—Oct. 22, 1898. No. 23684.

Screening.

Graphic Records of the Screening of Crushed Materials. Courtenay DeKalb Results of studies of the behavior of ores or rocks when subjected to crushing under different conditions. 2000 w. Am Inst of Min Engs—Oct., 1898. No. 23371 D.

Smelting.

Zinc Smelting in the Joplin District. E. Hedburg. The process used is described and some figures as to cost and profit given. Ill. 1500 w. Mines & Min—Oct., 1898. No. 23172 C.

Stone.

The Stone Industry of Alabama. Eugene A. Smith. Information concerning the building and ornamental stones of this state. 1400 w. Eng & Min Jour—Oct. 1, 1898. No. 23102.

Tasmania.

The Igneous Rocks of Tasmania. W. H. Twelvetrees and W. F. Petterd. Investigations of the igneous petrology of this island. 5800 w. Trans of Aust Inst of Min Engs—Vol. V. No. 23385 G.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Acetylene. George French. An exposition of the wet process. 1500 w. Heat & Ven—Oct. 15, 1898. No. 23671.

Acetylene Plant for House Supplies. Considers the most promising sphere of usefulness to lie in the supply of buildings which are out of the reach of the mains of gas-works undertakings. Emphasizes the need of proper purification and comments favorably on the generator patented by Prof. Raoul Pictet of Germany. 1400 w. Jour of Gas Lgt—Oct. 4, 1898. No. 23361 A.

Dangers in the Generation and Use of Acetylene. (Ueber die Gefahren bei der Erzeugung und Verwendung von Acetylen.) Dr. H. Gerdes. An account of the experiments made at the Pintsch works at Berlin, showing that with reasonable precautions no serious dangers need be incurred. The use of mixed acetylene and oil-gas for lighting railway carriages is discussed. 6000 w. Glaser's Annalen—Sept. 15, 1898. No. 23540 D.

The Acetylene Gas Hazard. L. J. Krom. Contending that acetylene is no more dangerous than ordinary illuminating gas, and discussing the restrictions of proposed legislation, giving results of experiments. 1100 w. Sci Am—Oct. 8, 1898. No. 23234.

Wet and Dry Acetylene Generators. H. F. Fuller. Part first is confined to the wet process, discussing the advantages claimed. 1000 w. Heat & Ven—Oct. 15, 1898. Serial. 1st part. No. 23672.

Address.

Address of the President of the American Gas Light Association, at its Twenty-sixth Annual Meeting, Niagara Falls, N. Y. J. B. Crockett. Touches briefly on many questions of interest to this industry, considering the future outlook encouraging. 5500 w. Am Gas Lgt Jour—Oct. 24, 1898. No. 23631.

By-Products.

Producing Illuminating Gas and Coke in By-Product Coke Ovens. H. O. Hofman. An outline of the work done at Halifax, N. S., by the People's Light and Heat Co., and of the preliminary large-scale experiments made for the New England Gas & Coke Co., at Glassport, Pa., with the coal that is to be used in the new Boston plant. 3000 w. Eng & Min Jour—Oct. 8, 1898. Serial. 2 parts. No. 23197.

Carbide.

Analyses of Commercial Samples of Calcium Carbide. (Analyse de quelques Echantillons Industriels de Carbure de Calcium.) Henri Moissan. A communication to the French Academy showing the character and extent of the impurities in calcium carbide based upon the analyses of a number of samples from various sources. 2000 w. Comptes Rendus—Oct. 3, 1898. No. 23539 D.

The Present and Prospective Supply of Calcium Carbide. Brief report of the situation in Europe, the conditions of supply and price, which are likely to be greatly modified by the increased production. 900 w. Cons Repts—Sept., 1898. No. 23025 D.

Carbonization.

A Few Hints on Carbonization. S. Carpenter. Suggestions to young gas managers and students. 2200 w. Jour Gas Lgt—Sept. 27, 1898. No. 23240.

Development.

How Can We Make the Use of Gas More Universal? Henry L. Doherty. Read before the Am. Gas Lgt. Assn. at Niagara Falls. States reasons why gas is not used more generally for cooking, discussing each in order. 4800 w. Am Gas Lgt Jour—Oct. 31, 1898. No. 23702.

Gas Burners.

Introduction of Incandescent Gas Burners for Public Illumination at Paris. From the *Journal des Usines a Gaz.* Particulars relating to the installation of the Denayrouze incandescent gas burner in the principal streets and squares of Paris. 700 w. Am Gas Lgt Jour—Oct. 3, 1898. No. 23168.

Gas Mixtures.

On the Occurrence of Hydrogen Sulphide in

the Natural Gas of Point Abino, Canada; and on a Method for the Determination of Sulphur in Gas Mixtures. Francis C. Phillips, in Jour. Am. Chem. Soc. A summary of tests made at the wells and results obtained. Ill. 3000 w. Am Gas Lgt Jour—Sept. 26, 1898. No. 23043.

Gas Statistics.

New York State Gas Statistics. Interesting facts from the 15th Annual Report of the Bureau of Labor Statistics of New York for the year 1897. 1600 w. Pro Age—Oct. 1, 1898. No. 23110.

Meters.

Prepayment Meters in Manchester, England. Charles Nickson. A brief account of the difficulties, increased demand for gas, and the financial results from their introduction. One year's collection of pennies amounted to 4,727,541, or a weight of 44 tons. 900 w. Gas Wld—Sept. 24, 1898. No. 23121 A.

New Gas.

A New Gas. Charles F. Brush. Read before the Am. Assn. for the Adv. of Science. A brief account of the circumstances that led to the discovery. The chief characteristic thus far ascertained is enormous heat conductivity at low pressures. 5000 w. Science—Oct. 14, 1898. No. 23348.

Oxide.

The Manufacture of "Oxide" in the Gas Works, from the Standpoint of the Man Outside. W. H. Birchmore. Discussion of points in the manufacture of oxide, and the variation in the products bearing this name. 2800 w. Am Gas Lgt Jour—Oct. 17, 1898. No. 23402.

Standards.

A Comparison of the Hefner and Carcel Lamps as Standards of Light. Relates to the researches of M. Laporte, and the conclusions drawn from his results. 900 w. Jour of Gas Lgt.—Oct. 11, 1898. No. 23448 A.

Water Gas.

Dellwik's Water Gas. Abstract of a lecture recently delivered by the inventor before the Swedish Teknologförening at Stockholm, describing the producer and discussing the manipulation, composition and cost. Ill. 900 w. Gas Wld—Oct. 1, 1898. No. 23268 A.

Welsbach Mantles.

Deterioration of the Candle Power of Welsbach Mantles. Report of recent investigations claiming to show that the drop in candle power of Welsbach mantles is even more rapid than that of the filaments of incandescent lamps. 600 w. Elec Wld—Oct. 1, 1898. No. 23089.

SEWERAGE.

Concrete Pipes.

A French Achievement. Describes a sewage force-main 4.793 ft. long built of concrete and steel bars. 800 w. Eng Rec—Oct. 22, 1898. No. 23622.

Purification.

Purification of Sewage by Irrigation. W. M. Watson. Discusses methods and their degree of success, describing the sewage form of St. Laurent College, near Montreal and also the sewage works of the Georgean Bay district. 1700 w. Can Eng—Oct., 1898. No. 23298.

Purification of Sewage by Mixing with Pure Water. W. M. Watson. Thinks it perhaps possible that a rapid flowing river might purify its contents, but considers it improbable that it will purify raw sewage. 1300 w. Can Eng—Oct., 1898. No. 23302.

Sewage Disposal.

A Short History of Sewage Disposal at the Asylum for the Insane, London, Ontario. R. M. Bucke. Read before the Ontario Assn. of Executive Health Officers at Ottawa. Describes an intermittent downward filtration plant, stating its advantages. 1400 w. Can Eng—Oct., 1898. No. 23300.

Recent Methods of Sewage Disposal. Charles G. Horetzky. Read before the Assn. of Executive Health Officers of Ontario, and before the Am. Public Health Assn. Considers the most recent methods in operation in the United States, with remarks on their adaptability to cities in Canada. 3300 w. Can Eng—Oct, 1898. No. 23301.

Sewage Disposal at Friern Barnet, England. James H. Fuertes. Illustrated description of a plant with many ingenious mechanical devices, which was built by Baldwin Latham in 1887. Chemical treatment and filtration are employed. 1300 w. Eng Rec—Oct. 15, 1898. Serial. 1st part. No. 23358.

The Essential Conditions of Bacterial Sewage Purification. A paper read before the British Assn. by W. I. Dibdin and George Thudichum. Gives the history of bacterial processes, and discusses air supply, temperature, light, reaction, time of contact, nature of bed material, and depth of bed. 3500 w. Eng Rec—Oct. 8, 1898. No. 23185.

The Septic Tank at Portadown, Ireland. Description of plant treating 22,000 gallons of sewage daily by the Exeter bacterial system. 1200 w. Eng Rec—Oct. 1, 1898. No. 23158.

Sewerage Systems.

A Comparison of the Combined and Separate Systems of Sewerage. C. P. Collins. A general discussion of systems in use, with explanation of the combined and separate systems, favoring the latter. 2500 w. Munic Engng—Oct., 1898. No. 23116 C.

Sewer Pipe.

Sewer Pipe Manufactured in England. J. A. Turner. An account of the material used and an illustrated description of the more recent methods. 3800 w. Brick—Oct., 1898. No. 23254.

Sewers.

Notes on Storm-Water Sewers. Explains the determination of their sizes and gives a diagram for estimating the rain fall for which they should be proportioned. 2200 w. Eng Rec—Oct. 1, 1898. No. 23157.

The North Carolina Avenue Concrete Sewer, Washington, D. C. Alexander Crawford Chenowith. Six illustrations of different stages of the work with description. 600 w. Stone—Oct., 1898. No. 23487 C.

STREETS AND PAVEMENTS.

Boulevards.

Parkways and Boulevards in American Cities. Sylvester Baxter. Introductory remarks upon the extensive improvements in this line in European cities, with a discussion of the drives of New York city are given in part first. 3500 w. Am Arch—Oct. 8, 1898. Serial. 1st part. No. 23252.

Curbs.

The Proper Curbing of Streets. Horace Andrews. Abstract of paper presented at meeting of Am. Soc. of Munic. Imp. Mainly a description of experience at Albany, N Y. 1200 w. Eng Rec—Oct. 29, 1898. No. 23696.

Paving Brick.

What Should Be Expected of Paving Brick? Extract from a paper by F. P. Anderson, on an exhaustive series of paving brick tests, dealing also with the foundation, laying, &c. 3000 w. Clay Rec—Oct. 10, 1898. No. 23431.

Promenades.

Streets and Promenades. From *Building News* (England). Brief comparison of the streets of England and the Continent. 1400 w. Ill Car & Build—Sept. 30, 1898. No. 23261.

Street Lighting.

The Cost of Street Lighting. A statement of the method of comparing costs in different cities. Discussing facts presented in a report by N. Matthews, Jr. 1500 w. Eng Rec—Oct. 8, 1898. No. 23181.

Tree Planting.

Tree Planting in the Streets of Washington. William P. Richards. An outline of this enterprise which is under the direction of the District authorities, with facts and opinions relating to it. 2400 w. Munic Engng—Nov., 1898. No. 23700 C.

Wood Paving.

Notes on Wood Paving vs. Macadam. J. Stirrat. A statement of experiments made in Rangoon, using teak and pyinkadoe laid on a cement concrete foundation. Ill. 1000 w. Ind Engng—Sept. 10, 1898. No. 23403 D.

WATER SUPPLY.

Aix-la-Chapelle.

The Extension of the Water Works of Aix-la-Chapelle. (Die Erweiterung des Wasserwerkes der Stadt Aachen.) With map showing the additional sources of supply, also a discussion of the probable increased demand, and a description of the covered reservoirs used. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 17, 1898. No. 23523 D.

Croton Dam.

Progress on the New Croton Dam. Recent views of the work with report of the progress and the amount of excavation and other work already accomplished. 1500 w. Eng News—Oct. 20, 1898. No. 23458.

Dam.

Specifications for a Large Concrete Dam. Reviews the leading features of some unusual specifications for a structure to be built across the Scioto River. 900 w. Eng Rec—Oct. 29, 1898. No. 23694.

East London.

The East London Water Company. Vaughan Nash. A statement of the failure of the company to provide the district with water, the history of the undertaking, and severe criticism. 1800 w. Contemporary Rev—Oct., 1898. No. 23367 D.

Edinburgh.

The Water Works of Edinburgh. James H. Fuertes. Illustrated description of the system adopted. 900 w. Eng Rec—Oct. 29, 1898. Serial. 1st part. No. 23695.

Electrolysis.

See Street and Electric Tramways.

Gas Engines.

Gas Engines for Small Water-Works. Their advantage in economy and ease of operation is discussed. 700 w. Eng Rec—Oct. 8, 1898. No. 23182.

The Gas Engine Pumping Plants of the East Pittsburg Water Company. George S. Davison. Illustrated description of works requiring a number of small pumping stations, where gas engines were found particularly useful. 1500 w. Eng Rec—Oct. 8, 1898. No. 23186.

Litigation.

The Beaver Falls Water-Works Case. Reviews a Pennsylvania decision preventing a borough from building works when it has already given a company a franchise. 700 w. Eng Rec—Oct. 1, 1898. No. 23154.

Meter Tests.

Meter Testing, Somerville, Mass. Illustrated description of apparatus for water-meter tests. 600 w. Eng Rec—Oct. 8, 1898. No. 23184.

Pipe Line.

The Coolgardie Pipe Line; A Remarkable Engineering Problem. Editorial discussing the project for furnishing water to this gold-mining district of Western Australia, giving extracts from the final report of the Board of Consulting Engineers. 3000 w. Eng News—Oct. 13, 1898. No. 23337.

Pitot Tubes.

Experimental Investigation of the Reliability of Pitot Tubes for Determining the Velocity of Flow of Water in Pipes. J. Fraley Baker and Harvey Brett. Graduation thesis. Gives illustrated account of experiments and results. 1600 w. Stevens Ind—Oct., 1898. No. 23648 D.

Plymouth.

Plymouth Water Works. Gives a brief account of the celebration in honor of the completion of the new reservoir in Dartmoor, and outline of the history of the water supply of Plymouth, Eng., with illustrations. 1700 w. Engng—Sept. 23, 1898. Serial. 1st part. No. 23148 A.

Purification Plant.

Progress on the Water Purification Plant at Albany, N. Y. An illustrated account of the

present state of this interesting piece of engineering work. 1000 w. Eng News—Oct. 20, 1898. No. 23463.

Stave Pipe.

Stave Pipe—Its Economic Design and the Economy of Its Use. Arthur L. Adams. Discusses the essential considerations in stave pipe design, and some of the practical and theoretical limitations imposed. Studies several existing lines, outlines a method for making a safe and economic design, and endeavors to determine the rightful place of stave pipe in economic construction. 10,800 w. Pro Am Soc of Civ Engs—Sept., 1898. No. 23066 F.

Subaqueous Tunnel.

A Submerged Water Main Tunnel, Cleveland, O. Illustrated description of a tunnel 575 feet long, carrying a 48-in. riveted-steel pipe under a river. 1600 w. Eng Rec—Oct. 22, 1898. No. 23626.

MISCELLANY.

Assessments.

Assessment for Sewers and Water Mains. Charles Carroll Brown. Proposes a method of assessment which is in a measure proportional to the amount of use made of the system. 800 w. Munic Engng—Oct., 1898. No. 23114 C.

Garbage Disposal.

How San Francisco Disposes of Its Garbage. Compares the methods of New York and San Francisco, giving an illustrated description of the Thackeray process of incineration used by the latter city. 2000 w. Sci Am—Oct. 22, 1898. No. 23466.

Municipal Ownership.

Some Views and Data on Municipal Ownership. Henry Hopkins. States the reasons that warrant a municipal plant, and discusses why they are not usually desirable. 500 w. Elec Eng, N. Y.—Oct. 13, 1898. Serial. 1st part. No. 23316.

Municipal Reform.

The Movement for Municipal Reform. Clinton Rogers Woodruff. Reviews the ways in which reformers are working and the effort to bring them into closer relations and to increase the public interest. 3000 w. N Am Rev—Oct., 1898. No. 23208 D.

Recreation.

Gymnasiums and Playgrounds. A paper by Mayor Quincy, of Boston, read at the Social Science Convention at Saratoga. The importance of the bath, gymnasium, and playground in promoting civilization in great cities. 2500 w. San—Oct., 1898. No. 23205 D.

Smoke Prevention.

See Mechanical Engineering, Furnaces.

Washington, D. C.

The National Capital: Its Pavements and Parks, and Its Form of Government. An interesting account of the city and some of the improvements deserving attention; given in view of the annual meeting of the Munic. Improvement Society to be held in this city. Ill. 4000 w. Munic Engng—Oct., 1898. No. 23113 C.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in August. A detailed list and classified summary of accidents during August, 1898, in the United States. 4000 w. R R Gaz—Sept. 30, 1898. No. 23080.

Speeds.

Railway Speeds. W. M. A. With editorial. The writer presents arguments for and against high speed, and the editorial criticises these arguments. 3800 w. Engr, Lond—Oct. 14, 1898. No. 29612 A.

Trainloads.

Trainloads on the Northern Pacific. Important statements and figures bearing on this subject from the last annual report. 900 w. R R Gaz—Oct. 7, 1898. No. 23250.

Transport.

The Cost of Transport. (Les Prix de Transport.) A discussion of the relative cost of merchandise transport in France by rail and by canal, showing the economy of canal transport to be less than is generally supposed. 1500 w. Moniteur Industriel—Sept. 17, 1898. No. 23565 G.

FINANCIAL.

Earnings.

Progressive Gains in Railroad Earnings. A very satisfactory report for September, with tabulated statements for comparison. 1400 w. Bradstreet's—Oct. 15, 1898. No. 23352.

Supplies.

The Purchase and Inspection of Railroad Supplies. H. B. Hodges. Extracts from a paper presented at the meeting of the N. Y. R. R. Club. Advises the purchasing of only the best quality of material. 1800 w. R R Gaz—Oct. 28, 1898. No. 23691.

LEGAL MATTERS.

Court Decision.

Joint Traffic Association Declared Illegal. The decision of the U. S. Supreme Court against the railroads, with editorial comment. 3300 w. R R Gaz—Oct. 28, 1898. No. 23687.

The Railroads and the Joint Traffic Decision. Discusses the power of Congress over railroad traffic and the effect of the recent decision of the U. S. Supreme Court. 1800 w. Bradstreet's—Oct. 29, 1898. No. 23697.

Rates.

The Fixing of Minimum Rates. Editorial

discussion of the need of legislation regulating both the maxima and minima of tariff rates. 1000 w. Ry & Engng Rev—Oct. 1, 1898. No. 23222.

MOTIVE POWER AND EQUIPMENT.

Annunciator.

A Train-Order Annunciator for Locomotive Cabs. A recording device, invented by Harry De Wallace, which warns by sight and sound when approaching a meeting point, crossing, &c., and would stop the train, if the engineer neglects his duty. Ill. 1500 w. Eng News—Oct. 27, 1898. No. 23675.

Box Car.

Northern Pacific 70,000 lbs. Capacity Box Car. Engravings showing the principal features, and also the steel truck. 1400 w. R R Gaz—Sept. 30, 1898. No. 23079.

Brakes.

Some Fine Features of the High-Speed Brake. Illustrates and discusses some ingenious features of the device. 1200 w. Loc Engng—Oct., 1898. No. 23215 c.

Car Designs.

Two New Car Designs—Northern Pacific Railway. Illustrated description of a hopper-bottom coal-car of 50-tons capacity, only 30 ft. long and weighing 35,000 lbs.; and a box car of 70,000 lbs. capacity. 1200 w. Am Eng & R R Jour—Oct., 1898. No. 23093 c.

Coupler.

A Substitute Knuckle for M. C. B. Couplers. Illustrated description of a device to be used in case of knuckle breakage, and its method of application. 600 w. Ry Mas Mech—Oct., 1898. No. 23257.

Cylinder Fastenings.

Best Fastenings for Locomotive Cylinders. Supplementary report by J. E. Sague constituting an additional discussion of this subject. Ill. 2000 w. Ry & Engng Rev—Oct. 8, 1898. No. 23306.

Derrick Car.

Derrick Car, C. M. & St. P. Ry. Illustrates and describes a new form of derrick car used in connection with the bridge erection and track elevation work on the Chicago, Milwaukee and St. Paul road. 900 w. Ry & Engng Rev—Oct. 15, 1898. No. 23433.

Equipment Painting.

Economy in Railroad Equipment Painting. Extracts from a paper by Charles E. Copp, read before the New England R. R. Club. Describes the main points of economy and the treatment now given the equipment. 1500 w. R R Gaz—Oct. 14, 1898. No. 23340.

Explosion.

Explosion of a Mountain Locomotive at Prescott, Arizona. Engravings showing the complete destruction, with brief description. 800 w. Sci Am—Oct. 8, 1898. No. 23233.

Furniture Cars.

The New 50-Ft. Furniture Cars of the Chicago, Rock Island & Pacific Ry. Some enormous cars, exceptionally large even for furniture cars, are illustrated and described. 1300 w Eng News—Oct. 27, 1898. No. 23674.

Grates.

Locomotive Grates. M. N. Forney. A discussion of grate areas and description of grate designed by the writer, but which has never been practically tested, with consideration of the question of combustion. Ill. 3300 w. Am Eng & R R Jour—Oct., 1898. No. 23090 c.

Locomotives.

A Remarkable Locomotive. Illustrated description from the "Bulletin" of the International Railway Congress, of a locomotive invented some years ago by Messieurs H. Thuile and Fouré, with a view of attaining far higher speeds than had then been reached. 500 w. Engr, Lond—Sept. 30, 1898. No. 23293 A.

A Schenectady Mogul for the New York Central. Engraving showing appearance, with dimensions and other particulars. 700 w. R R Gaz—Oct. 28, 1898. No. 23690.

Great Northern Ten-Wheel Passenger Locomotive Built by Brooks Locomotive Works of Dunkirk, N. Y. Illustrated description and principal dimensions of what is claimed to be the heaviest passenger engine in use. 1800 w. Ry & Engng Rev—Sept. 24, 1898. No. 23054.

Narrow Gauge Locomotives—Interoceanic Railway, Mexico. Photographs and particulars of two designs built at the Schenectady works. 800 w. Am Eng & R R Jour—Oct., 1898. No. 23092 c.

New Express Engine for the North-Eastern Railway. Charles Rous-Marten. Describes a new experiment of Mr. Wilson Worsdell of the North-Eastern Railway, England. 1500 w. Engr, Lond—Oct. 14, 1898. No. 23613 A.

Ten-Wheel Engines for the Boston & Maine. Engraving and descriptive specifications of freight engines recently ordered. 600 w. R R Gaz—Oct. 21, 1898. No. 23474.

Ten-Wheel Passenger Locomotives for the Fitchburg. Engraving and principal dimensions of engine guaranteed to haul a train of 325 tons up a 60-ft. grade 10 miles long, at a speed of 40 miles an hour. 200 w. R R Gaz—Oct. 21, 1898. No. 23476.

Ten-Wheel Passenger Locomotives—Great Northern Railway. Illustrated detailed description with chief dimensions of locomotives built at the Brooks works, Dunkirk, N. Y. 1500 w. Am Eng & R R Jour—Oct., 1898. No. 23091 c.

Tests of the New 10-Wheel Locomotives of the Great Northern. An account of tests giving general results and sample indicator diagrams taken. 1200 w. R R Gaz—Oct. 14, 1898. No. 23338.

The Largest Locomotive Ever built. Illustrated description of a consolidation locomotive built for the Union R. R. Co. of Pittsburg, Pa., by the Pittsburg Locomotive & Car Works. 1200 w. Eng News—Oct. 27, 1898. No. 23673.

The Locomotives of the Belgian State Railways. (Les Locomotives des Chemins de Fer de l'Etat Belge.) M. Morizot. An illustrated description of the engines shown at the Brussels-Tervueren exhibition, giving details and elevations, together with comments on the peculiari-

ties of Belgian locomotives. 8000 w. 3 plates. Rev Gen des Chemins de Fer—Oct., 1898. No. 23536 F.

Pile-Driver Car.

Pile-Driver Car, L. S. & M. S. Ry. Detailed drawings with brief description. 600 w. Ry Mas Mech—Oct., 1898. No. 23256.

Poling Car.

Standard Poling Car; Pennsylvania R. R. Illustrates and describes the latest type of poling car, explaining its use. 700 w. Eng News—Oct. 13, 1898. No. 23335.

Resistance.

Train Resistance. Letters to the editor taking exception to previous editorial on this subject, with an editorial reply. 2500 w. Engr, Lond—Sept. 23, 1898. No. 23143 A.

Side Bearings.

Side Bearings for Cars. A. M. Waitt. Letter to the editor giving the writer's views. 1000 w. Am Eng & R R Jour—Oct. 1898. No. 23094 C.

Testing.

A Scheme for Testing Locomotive Boilers in Fast Express Service in Comparatively Short Runs. Howard H. Maxfield. The scheme described is the result of a series of tests of engines on the fast express service between Jersey City and Philadelphia, dealing only with the boiler part of the locomotive. 3800 w. Stevens Ind—Oct., 1898. No. 23649 D.

Trucks.

Car Truck Construction. Extracts from a paper by J. C. Barber, read at the Sept. meeting of the Northwest Railway Club. Advocates the diamond frame or arch-bar type. 2000 w. R R Gaz—Oct. 21., 1898. No. 23477.

The Single vs. the Double Truck Car. A letter from J. Hector Graham, taking exceptions to some of Mr. McCulloch's views. 1600 w. Elec, N. Y.—Sept. 28, 1898. No. 23072.

NEW PROJECTS.

Chinese Railroad.

The Chinese Eastern Railroad. M. Sergey Friede. An interesting account of the rapid growth of towns and cities along this route, the richness of Manchuria, the scope of the Siberian railroad, and the vastness of the enterprise. Ill. 2500 w. R R Gaz—Sept. 30, 1898. No. 23078.

East Africa.

The German East-African Central Railway. (Die Deutsch-Ostafrikanische Centralbahn.) H. von Schwabe. With profiles, data of cost, and general details of the programme. 2500 w. Glaser's Annalen—Oct., 1898. No. 23541 D.

Location.

The Technics of Railway Location. (Technische Tracirung.) Franz Hafferl. Devoted especially to the location of tramways, and local railways, with detailed descriptions of the Tichy-Starke Tachymeter. 4000 w. Mitt d Ver f d Förd d Local u Strassenbahwesens—Sept., 1898. No. 23575 E.

New Zealand.

New Zealand Railways. Information from the report of A. J. Cadman, the Present Minister for Railways, showing a most satisfactory year's working. 1200 w. Transport—Sept. 16, 1898. No. 23048 A.

Pike's Peak.

The Pike's Peak Railway. An illustrated account of this railway to the summit. It is built upon the Apt system. Also describes the equipment. 1500 w. Ry Age—Sept. 30, 1898. No. 23212.

Pioneer Construction.

Pioneer Railway Construction in New Countries. Editorial discussion of this subject, with special reference to China. Advises a cheap construction which will greatly reduce the cost of transit, executed through a large extent of country in the shortest possible time. 3000 w. Eng News—Sept. 29, 1898. No. 23075.

PERMANENT WAY, BUILDING AND FIXTURES.

Block Working.

Three Lessons from England. Editorial discussion of investigations of accidents given in the last British Board of Trade report, which show the difference between American and English practice. 3600 w. R R Gaz—Oct. 7, 1898. No. 23251.

Dresden.

The Railway Stations in Dresden. (Die Bahnhofsanlagen in Dresden.) H. Von Köpcke. A description of the new passenger station at Dresden; also the new goods station, yards, bridge, and general terminal details. 6000 w. 2 plates. Zeitschr d Ver Deutscher Ing—Oct. 8, 1898. No. 23530 D.

Inundated Districts.

Railway Construction in Districts Subject to Inundation. A discussion of the subject appearing to prove the economic value of the low-level system in spite of short interruptions to traffic. 2000 w. Eng News—Sept. 29, 1898. No. 23076.

Light Railroads.

The High Cost of Light Railroads in England. W. M. Acworth. Does not consider that light railways are likely to prove remunerative undertakings, unless their capital cost can be brought down. 700 w. R R Gaz—Sept. 30, 1898. No. 23077.

Mexico.

The Mexico, Cuernavaca and Pacific Railroad. H. W. Reed. A letter to the editor describing engineering construction, equipment and operation of the highest order. 800 w. R R Gaz—Oct. 7, 1898. No. 23249.

Omaha.

The New Burlington Station at Omaha, Neb. Illustrated description of a substantial building of brick and stone, well adapted to its intended use. 500 w. Ry Age—Sept. 30, 1898. No. 23211.

Rails.

Stresses in Rails Under Moving Loads. Records made during the hot weather of June

and July with the "stremmatograph" devised by F. H. Dudley, with discussion. 4500 w. R R Gaz—Oct. 21, 1898. No. 23475.

Rail Splice.

A New Rail Splice and an Anti Creeper for Steam Railway Tracks. Illustrated description of the device for preventing rails from creeping, designed by A. Bonzano. 800 w. Eng News—Oct. 20, 1898. No. 23459.

Shops.

The Omiya Shops of the Nippon Railway of Japan. W. C. Tyler. Diagram and description of carefully planned shops, the finest in the Far East. 1200 w. Ry & Engng Rev—Oct. 1, 1898. No. 23221.

Signals.

The Thomas Stand, for Switch and Distant Signal. Illustrated description of a stand which has a spring connection with the points at all times and a stiff connection while the points are being thrown. 800 w. Ry & Engng Rev—Oct. 8, 1898. No. 23305.

Sleepers.

Comparative Experiments with Iron Sleepers. (Vergleichende Versuche mit Eisernen Querschwellen.) Ch. Renson. Report of tests made on the Liége-Limburg railway for the past 17 years, with illustrations of the most satisfactory type. 4000 w. Stahl und Eisen—Sept. 15, 1898. No. 23562 D.

Report on the Testing of Metallic Sleepers on the Liége-Limburg Railway. Ch. Renson. A very complete series of tests, lasting over 17 years, conclusively showing the advantages of metallic sleepers over those of oak. 8000 w. Bulletin Int Railway Congress—Sept., 1898. No. 23538 H.

Stations.

The Great Railway Stations of England. Thomas Cargill. The second paper contains many views and plans of important stations, with comments on the construction and arrangement. 4000 w. Engineering Magazine—Nov., 1898. No. 23592 B.

The New Station and Yards at Nashville. Plan showing the proposed arrangement as revised, and the portion of the work that will be done immediately, with brief description. 700 w. R R Gaz—Oct. 28, 1898. No. 23688.

See Architecture and Building, Heating.

Superintendent.

The Superintendent of Bridges and Buildings. Onward Bates. Lecture delivered before the students of the College of Mechanics and Engineering, Univ. of Wisconsin, 1898. Discussing the personality, duties, responsibilities, education and experience he should possess. 10,500 w. Bul of Univ of Wis—No. 26. No. 23321 C.

Tamping.

Recent Experiments in Tamping Track by Compressed Air. F. R. Coates. Read before the New England Roadmasters' Assn., Boston. Remarks the lack of progress made in surfacing track, and reviews some recent work in the use of the air blast. 3300 w. Compressed Air—Oct., 1898. No. 23204.

Turntable.

Electric Capstan and Turntable Gear; Northern Railway of France. Illustrated detailed description. 1200 w. Engng—Oct., 7, 1898. Serial. 1st part. No. 23417 A.

Electric Turntable for the Erie Railroad. Describes an installation at Jersey City, which is in effect, a small drawbridge, the essential difference being that the table seesaws over the center. Illustrations and editorial. 2000 w. R R Gaz—Oct. 14, 1898. No. 23341.

STREET AND ELECTRIC TRAMWAYS.

Berlin Railways.

The Metropolitan and Belt Railways of Berlin. Abstracted from the *Revue Generale des Chemins de Fer*. Illustrated description. 1700 w. Eng News—Oct. 6, 1898. No. 23245.

Boston Subway.

The Completion of the Boston Subway and New Arrangements of Street Cars. States the alterations in plans made necessary by new developments in connection with the Boston Elevated Railway. Describes the stations, stairways, and other interesting particulars. Ill. 2800 w. R R Gaz—Oct. 21, 1898. No. 23478.

Bradford.

Bradford Municipal Electric Tramways. Illustrated detailed description of the road and its equipment. 3400 w. Ry Wld—Oct. 13, 1898. No. 23450 A.

Brakes.

The Use of Electric Brakes on Tramways. (Ueber die Verwendung Elektrischer Bremsen beim Strassenbahn Betriebe.) Especially illustrating and describing the Siemens & Halske magnetic brake. 800 w. Mitt d Ver f d Förd d Local u Strassenbahnwesens—Sept., 1898. No. 23576 E.

Brussels.

Brussels' Electric Railways. Illustrates and describes the conduit trolley lines recently built. 1000 w. W Elect'n—Oct. 8, 1898. No. 23260.

Chicago.

Council Report on the Street Railways of Chicago. Discusses the report of the committee appointed by the city council to investigate the street railways, their franchises, financial operations, traffic conditions, and the wages paid to employees. 2700 w. Eng News—Oct. 20, 1898. No. 23461.

Conduits.

The Siemens & Halske System of Underground Conduits for Electric Roads. Gustav Braun. Abstract translation from the *Elektrotechnische Zeitschrift*. Illustrates and describes the system in use in Germany and Austria. It differs from American practice and has ingenious features of interest. Also editorial. 2500 w. Elec Wld—Oct. 15, 1898. No. 23327.

Cripple Creek.

Cripple Creek District Railway. Illustrates and describes a road which has adopted the three-phase system with current generated at high pressure, transmitted, reduced and converted. The source of power is the flow from the different watersheds of Pike's Peak. 1700 w. St Ry Rev—Oct. 15, 1898. No. 23452 C.

Electric Traction.

Notes on the Electric Traction of Trains in the United States. (Notes sur la Traction Electrique des Trains aux Etats-Unis.) An interesting paper containing the observations of a party of engineers of the Orleans Railway Company during a recent visit of inspection in America. 10,000 w. Rev Gen des Chemins de Fer—Oct., 1898. No. 23535 F.

Electrolysis.

Electrolysis of Water Mains in Dayton, Ohio. Describes the state of 46,000 ft. of pipe costing $77,000. 1200 w. Eng Rec—Oct. 22, 1898. No. 23623.

Glasgow.

Electric Traction in Glasgow. Illustrates and describes the first electric tramway constructed in Glasgow, giving interesting particulars. 3800 w. Ry Wld—Oct. 13, 1898. No. 23451 A.

Jungfrau.

The Jungfrau Electric Railway. Illustrated description of this great work in Switzerland. 1500 w. Elec Wld—Oct. 15, 1898. No. 23325.

London.

The Waterloo and City Railway. W. B. Paley. Information concerning the operation and equipment of this road. 1000 w. Mech Wld—Sept. 23, 1898. No. 23223 A.

Measurements.

Watt-Hour Measurements on the Motive Power of the Berlin Charlottenburg Tramway. (Wattstundenmessungen an den Betriebsmitteln der Berlin-Charlottenburger Strassenbahn.) Max Schiemann. A very full account of tests made on an accumulator system, measuring the watt-hours used, and also the capacity of the accumulators. 5000 w. Elektrotech Zeitschr—Oct. 6, 1898. No. 23551 B.

Mountain Railway.

Mount Lowe Electric Mountain Railway. Olaf Ellison. Illustrates and describes a scenic railway in California. 2000 w. Sci Am—Oct. 29, 1898. No. 23668.

New York.

Reconstruction of New York Street Railways. Some facts regarding the recent improvements, and their cost, the magnitude and merit of the work, &c. 1000 w. Sci Am—Oct. 22, 1898. No. 23465.

Public Relations.

The Relation between the Public and Street Railway Companies. J. T. Little, Jr. Read before the Street Ry. Assn. of the State of N.Y. An article showing in a rather amusing way the demands of the people, and the efforts of the company to meet these demands. 3000 w. St. Ry Rev—Oct. 15, 1898. No. 23453 C.

Storage Batteries.

A Study of the Storage Battery Performance on the South Side Elevated Railroad of Chicago. J. R. Cravath. Considers the uses and performance of the battery installed. 1800 w. Elec Eng, N. Y.—Oct. 13, 1898. No. 23319.

The Storage Battery Auxiliary of the Brunswick Traction Company. Illustrates and describes a storage battery sub-station in use on a New Jersey line and found very satisfactory. 1000 w. Elec Wld—Oct. 29, 1898. No. 23666.

Surface Contact.

Electric Traction by Surface Contacts. S. P. Thompson and Miles Walker. Paper read before the British Assn. Reviews the systems based upon this principle and describes some of the methods of operation, giving illustrations. Also describes an experimental line constructed by the writers in England. 3600 w. Elect'n, Lond—Sept. 30, 1898. No. 23270 A.

Suspension Railroad.

An Electric Suspension Railroad. Brief illustrated description of a road in process of construction in Prussia. 300 w. Sci Am Sup—Oct. 15, 1898. No. 23347.

Three-Phase.

Three-Phase Current Tramway at Evian-les-Bains.) Tramway à Courant Triphase d'Evian-les-Bains.) An illustrated account of this first three phase current tramway in France, with a profile of the road, and a scheme of the wiring. 1800 w. La Revue Technique—Sept. 25, 1898. No. 23507 D.

Three-Phase Railway at Evian-les-Bains. From *La Revue Technique* and *L'Industrie Electrique*. Describes an interesting short line, established to connect the hot baths with the Grand Hotel des Bains. Ill. 1600 w. Elec Eng, N. Y.—Oct. 20, 1898. No. 23441.

Trolley.

The Installation of Overhead Electric Trolley Wires. (L'Etablissement des Lignes Aériennes de Tramways Electriques.) A very complete mathematical discussion of the stresses in overhead trolley wires, taking into account the action of gravity, wind, and changes of temperature. 6000 w. La Revue Technique—Oct. 10, 1898. No. 23513 D.

Underground.

Underground Conductors for Eelectric Railways. (Die Unterirdische Stromzuführung für Elektrische Bahnen.) G. Braun. A very fully illustrated description of the Siemens & Halske system as used at Budapest and elsewhere. 3500 w. Elektrotech Zeitschr—Sept. 22, 1898. No. 23546 B.

Vienna.

The Ringstrasse-Prater Electric Tramway in Vienna. (Die Elektrische Betriebene Tramway Ringstrasse—k. k. Prater in Wien.) With map of the city, and details of track and cars. The combination of overhead trolley and storage battery is used. 3500 w. Mitt d Ver f d Förd d Local u Strassenbahnwesens—Sept., 1898. No. 23577 E.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine when you write.

Marine Iron Works, Incorporated, Chicago, Ill., U. S. A.=Catalogue of marine engines, boilers and general marine machinery, including single screw, twin-screw, side-paddle, and stern-wheel designs. Handsomely illustrated, and giving many useful details.

Gates Iron Works, Chicago, Ill., U. S. A.=General catalogue of mining machinery; milling, crushing, and power plants. A particularly beautiful specimen of typography, containing, in addition to illustrations of the products of the works, views of celebrated mills in various parts of the world.

B. F. Sturtevant Co., Boston, Mass., U. S. A.=Special pamphlet of the Sturtevant patent steam hot-blast apparatus, giving illustrations of the application of the system to a great variety of requirements.

W. W. Oliver, Buffalo, N. Y., U. S. A.=Catalogue of fine machinery, tools, and specialties for manufacturing jewelers, machinists, amateurs, etc., with many illustrations of high-grade tools for small work.

Wolverine Motor Works, Grand Rapids, Michigan, U. S. A.=Illustrating and describing the "Wolverine" gas and gasoline motors as especially adapted to launches and other boats. Illustrations of stationary motors and a plantation locomotive are also given.

San Francisco Bridge Company, San Francisco, Cal., U. S. A. New York Dredging Company, New York.=A very handsomely illustrated catalogue showing works completed and under construction by these companies, including piers, lighthouses, bridges, canals, and harbor works.

Meadville Vise Co., Meadville, Pa., U. S. A.=Large pamphlet catalogue of Barrett's horizontal cylinder boring machines, and of vises of all kinds.

George W. Lord, Philadelphia, Pa. U. S. A.=Essays upon Boiler Incrustation and Corrosion. A discussion of Lord's boiler compounds, and their applicability to various feed waters, as well as the causes of incrustation and corrosion.

Continental Iron Works, New York.=Handsomely bound catalogue of the Morison suspension furnaces, furnace fronts and doors for internal furnace tubular boilers. With formulas and tables showing working pressures and thicknesses of suspension furnaces, together with full working drawings of internal furnace boilers from 75 to 300 horse power.

Geo. V. Cresson, Co., Philadelphia, Pa., U.S.A.=Catalogue of power transmitting machinery, shafting, and appurtenances; including a full price list of balanced pulleys. The improved system of vertical shaft transmission is also shown, and a line of rope transmission and mill gearing, as well as hangers, couplings, &c.

John Grundy, 30 Duncan Terrace, City Road, London.=(*a*) Four-page pamphlet setting forth the merits of the "Helios" smoke-consuming grate and the "Hestia" ventilating stoves; (*b*) sixty-page pamphlet containing testimonials from users of Grundy's warm air heating system.

W. N. Nicholson & Sons, Ltd., Newark-on-Trent, England.=Catalogue and price list of agricultural machinery, including grinding mills, shredders, flour, and rice machinery. Very fully illustrated, with complete descriptions of the machines. Paper cover.

Marshall Sons & Co., Ltd., Britannia Iron Works, Gainsborough, England.=Well printed catalogue of steam engines, boilers, saws, and other machinery. Many fixed and portable types are described, including traction and hauling engines.

Turner Bros., Cambrian Iron Works, Newtown, North Wales.=(*a*) Leaflet describing a timber cross cutting machine; (*b* two cards describing saw-filing, planing, and slate sawing machines.

Lawrence Scott & Co., Gothic Works, Norwich, England.=Two small price lists of the "Norwich" dynamos and electric motors, with full dimensions, weights and prices.

J. D. F. Andrews & Co., Ltd., Putney Bridge Station, Fulham, London.=Price-list of "concentric" wiring conductors, joints, and sockets; also of fuse boxes, switch boards, electric light fittings, and ventilated resistances.

The Hancock Inspirator Company, Old Swan Wharf, London Bridge, London.=Catalogue of the Hancock Inspirators, with sizes, prices, and capacities.

Siebe, Gorman & Co., Westminster Bridge road, London.=Handsomely illustrated catalogue of diving apparatus, divided into three main parts: (1) specifications of diving apparatus; (2) list of separate parts of diving apparatus; (3) illustrated supplement of some notable submarine operations.

T. Ledward & Co., 35 Queen Victoria street, London.=Descriptive pamphlet on Ledward's patent evaporative condenser for steam engines, with illustrations and list of users.

Anti-Attrition Metal Co., Ltd., Emerson street, Southwark, London.=Price-lists, with testimonials of the anti-attrition metal Nos. 1 & 2, and of Babbitt's anti-friction metal.

H. Munzing, 199 Upper Thames street, London, E. C.=(*a*) catalogue, in French, of valves, steam fittings, vices, wrenches, etc.; (*b*) pamphlet describing the Howard Thermostat, or heat regulator; (*c*) circular relative to the Stillson wrench.